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ART. XVI.—*Notice of an Account of Geological Observations in China, Japan and Mongolia;* by RAPHAEL PUMPELLY.

[Read before the National Academy of Sciences,[1] Aug. 26th, 1865.]

IN the present brief notice, I propose to call attention to some of the principal conclusions to which I have been led by geological observations made during journeys in China and Mongolia. In a longer memoir I hope to give in detail the grounds on which these conclusions are based. The range of travel was as follows:

In the summer of 1863, from *Shanghai* to *Hunan* and the boundary between *Hupeh* and *Sz'chuen*.

In the autumn and winter of 1863 and 1864 and during the following spring, from *Peking* through the mountains of western *Chihli;* and from *Peking* to beyond the Great Wall of China and westward on the plateau, following its southern edge to about the 112th meridian, E. of Greenwich, returning by a route south of the Great Wall.

In the winter of 1864 and 1865, from *Peking* across the plateau of Central Asia, via *Kalgan* and *Urga*, and *Kiachta* in Siberia.

The almost total absence of previous observations of a geological character, through this wide field, the comparatively small amount of surface seen in the above journeys, and the great difficulties that a single observer has to contend with, owing to the jealousy of the inhabitants in the center of China, and the extreme cold of a winter journey over the table land, restricted my range of observation, and permit me to give in the paper I am

[1] The work to which this brief notice calls attention, and which the National Academy has kindly volunteered to publish in its memoirs, contains also an itinerary of geological observations in Japan, and will be accompanied by a considerable number of maps, sections and illustrations.

preparing only a general and necessarily very incomplete idea of the geology of that interesting country. The data at my service are: my own observations, the extremely limited number of those of other foreigners, and the information obtained from Chinese works on the geography of the empire, chiefly bearing on its mineral productions and scattered through an immense range of literature.

The chief results arrived at are as follows:

I. There is reason for believing that there exists throughout China, an immense development of Devonian limestone, which rises to the surface in all the important ridges, and attains in places a thickness of over 10,000 feet.

II. Wherever the formations beneath this limestone were seen, they were found to be, either granitic rocks, or metamorphic schists, non-conformably stratified as regards the limestone.

III. Overlying the limestone, there exists in almost every part of China, a great coal-bearing formation of sandstones, shales, conglomerates, etc., as a rule in nearly, if not quite, conformable stratification as regards its limestone floor. The fossil plants obtained from this formation in widely separated localities, in the province of *Chihli* and on the *Yangtse Kiang* in western *Hupeh*, are being examined by Dr. J. S. Newberry, who considers them to be decidedly supra-carboniferous. The absence of Carboniferous forms and the presence of Cycads closely resembling Triassic species, make it probable that the coal-fields of China, which vie with our own in extent, are referable to the Triassic period.

IV. Although from the limited range of actual observation, it would be assuming too much to assert that there is a total absence of all formations younger than the Chinese Coal-measures, still I failed to find any traces of them, and I feel justified in doubting the existence of marine Jurassic, Cretaceous or Tertiary deposits to any important extent, within the limits of the Eighteen Provinces, or China Proper, unless they may be represented on the frontiers of Assam, Burmah or Cochin China, or on the islands of Formosa or Hainan.

V. Excluding the N. S. ranges of mountains that form the eastern edge of the Thibetan highland, only two systems of elevations occur in China, of sufficient importance to have left a marked impress on the surface. These are the N.E., S.W. and the E.W. systems. The N.E. system of trends, in all eastern Asia, east of the 110th meridian, determines the outline of that part of the continent, and they, as well as nearly all the more important features of this region, can be represented by lines drawn parallel to a line running N. 47° E., and coinciding with the middle course of the *Yangtse Kiang* and the lower course of the *Amur*, with the longer axes of the Gulfs of *Penjinsk* and of *Pechele*, and with that of the depression occupied by the delta plain of the *Hwang Ho*.

The E.W. system exists in western China in the *Min* mountains and in the *Nan ling* range.

While the N.E. system has determined the eastern outlines of the continent, and much of its inland configuration, to the E. W. system is due the *general* course from west to east of the three principal rivers, the *Hwang Ho*, the *Yangtse Kiang* and the *Si Ho* of the south.

The disturbance of the N.E. system began after the deposition of the great Devonian limestone formation. It appears to have been acting slightly, during the forming of the coal-bearing beds, but its chief operation was after these had been deposited.

There is a striking analogy between this system and the Appalachians, both having the same trend, and, within certain limits, contemporaneous origin, and both folding immense areas of coal-bearing strata, and determining the eastern outlines of their respective continents.

I have taken the liberty of applying to this widely extended upheaval, the name of the SINIAN[2] system.

The E.W. system appears to be younger than the Sinian. It has raised the limestone and overlying rocks in the *Min* mountains and in the *Nan ling* range, and M. de Semenow found Carboniferous limestone forming synclinal folds in the longitudinal valleys of the *Tien shan*.

VI. Evidences of recent oscillations, extending over a great area, are visible in terraces on the coast of *Shantung*, along the whole course of the *Yangtse Kiang* from the sea to western *Sz'chuen*, and on the western skirt of the delta plain, as well as throughout the islands of Japan.

VII. The great plain of north-eastern China is a delta deposit, mainly of the *Hwang Ho*, stretching over nearly eight degrees of latitude and yearly increasing in extent. Within the limits of this delta the *Hwang Ho* varies its course every few centuries, emptying into the sea, alternately to the north and to the south of the mountainous peninsula of *Shantung*.

VIII. The great table land that lies between China and Siberia is made up, where my route crossed it, of basins of undisturbed strata of sandstone, probably younger Tertiary, containing, in places, beds of gypsum. These basins are separated by low ridges, often of granitic rocks, but more generally, of highly inclined and folded strata of schists, sandstones and limestones, etc., all highly metamorphosed. The general trend of these ridges is between E. and N.E.

In the south the plateau rises gently, terminating in a precipitous wall facing the S.S.E. Where I travelled along this southern edge, between the 112th and 115th meridians (E. of Green-

[2] From *Sinim*, the name under which the earliest mention of China is made; Isaiah, xlix, 12.

wich), it is formed by an immense development of lava flows, in places more than 1,500 feet thick. Wherever the rocks underlying this volcanic formation were observed, they were invariably found to be granitic, with metamorphic schists, chiefly gneiss, granulite and hornblendic varieties.

The abrupt termination of the plateau is owing to a great dislocation which marks, approximatively, the coast line of a former ocean to the north, in which the more recent deposits of the plateau originated, and along whose southern shore there existed an extensive region of volcanic activity.

This high escarpment seems to be the *Inshan*, and the fact that it is volcanic goes to prove the justness of Humboldt's belief, that the *Inshan* forms the continuation of the *Tienshan*.

While the plateau is terminated on the south by this escarpment, it is limited on the east by parallel ridges, and descends by successive terraces, to the Manchurian lowlands.

By the elevation of the plateau, north of this line of fracture, a great basin was formed between the escarpment and the range of mountains nearly marked, on the maps, by the Great Wall. This area became the seat of a series of lakes extending several hundred miles, from W.S.W. to E.N.E., and which have left a deposit of loam often visible in terraces several hundred feet thick. These lakes seem to have covered the whole land of the *Ortos*, within the great northern bend of the *Hwang Ho*, and the valley system of the *San Kang* and *Yang* rivers. The fresh-water character of the loam is proved by the presence of fresh-water shells.

The circumstances seem to warrant the supposition of a connected chain of lakes, stretching from the 106th to the 116th meridian, which received the waters of the *Hwang Ho*, before the formation of, or during a long continued obstruction of, the deep channel in which that river now flows between *Shansi* and *Shensi*. The main outlet seems to have been the present gorge, by which the *Yang Ho* traverses the mountains west of *Peking*, to join the *Pei Ho* of the delta plain.

The lower *Pei Ho* has, within historical times, more than once formed the mouth of the *Hwang Ho*.

Thus the *Hwang Ho* appears to present a most remarkable instance of one of the great rivers of the earth, not only shifting its lower course over an area of several degrees of latitude on its delta-plain, but also reaching the sea at the same point, at different times, after following two widely separated routes through a highly mountainous country.

IX. Among the more practical results obtained, I may mention the determination, from personal observation and from native sources, of a large number of extensive coal-basins, and of localities producing other useful minerals, all of which I have tabulated and represented, so far as is practicable, on a map.

These are so widely distributed throughout the empire, as to warrant the belief that China stands second to not even the most favored countries, as regards the quantity and quality of its coal and the long list of its other mineral resources.

Such great gifts of nature, combined as they are, with an unsurpassed variety of favorable circumstances, both climatal and structural, cannot long lie idle; they are the elements of the civilization of the present age, and in the natural course of events, the country possessing them cannot avoid being drawn into the stream of industrial and intellectual progress. They seem to predetermine a future history for that distant people; for, far from witnessing the often asserted signs of decay in the Chinese race, I am, and I think every careful observer must be, rather astonished at the evidences of a most remarkable vitality.

ART. XVII.—*The present annual effect of the secular change of the Magnetic Declination in the Eastern part of the United States, accompanied by a Chart;* by CHARLES A. SCHOTT, Assistant U. S. Coast Survey.

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IN a preceding number of this Journal (vol. xxix, May, 1860), I have given a special discussion of the secular variation to which the magnetic declination in the eastern portion of the United States appears to be subject: in the present communication will be found some additional material, since collected, with a chart of isomagnetic curves of the *annual change* of the declination. As a first attempt, this chart can claim but very moderate accuracy; it has been supposed, however, that enough information had accumulated to attempt its construction.

The curves unite places of equal annual change and by their distribution furnish us with ready means to refer any observed magnetic declination (within their limits) taken within the past decade, to the present value or to an epoch a few years in advance. These lines themselves change in the course of time, as is sufficiently plain from the discussion above referred to, but they may be taken to answer for about a decade either way from date, without passing beyond the limit of uncertainty to which they are subject themselves. The year 1860 may be taken for their average epoch.

The curves marked thus: II, III, IV, V, indicate the localities where the *annual* increase of west declination amounted, on the average, to as many minutes, between the years 1850 and 1860.

The change at Eastport, Me., $+1'{\cdot}6$ appears singularly small, but monthly observations, continued between 1860 and 1864, and a verification of last summer, will not admit of any other

value. For the greater part of our Atlantic coast the annual change is confined between +2′ and +3′, less on the southern coast, the careful observations at Key West between 1860 and 1865 give the comparatively large value +2′·9. Proceeding westward, on the Gulf coast the annual change becomes less, and at the Mississippi delta it is but a fraction of a minute. The Coast Survey report of 1861, pp. 252 and 256, contains the numerical quantities for our southern coast.

If we start from the extreme northeast, in a southwesterly direction, we shall find the annual change as follows: along the St. Lawrence river between the Saguenay river and Quebec +6′; between Quebec and Montreal about +5′; between Montreal and Kingston about +4′; at Portland, Me. +3′·2 (from the most recent observations); along Lake Ontario +4′; at Toronto +3′·1 (from a table of absolute value published by G. T. Kingston, director of the observatory); at Buffalo +3′·6; at Dunkirk +4′·3; at Lake St. Clair +2′·9. The average value for Pennsylvania is about +2′·7 (see record and results of a magnetic survey of Pennsylvania, etc. etc., by A. D. Bache, LL.D., Smithsonian Contributions to Knowledge, Oct. 1863). At Parkersburg, Western Va. +3′·2; at Cairo, Ill. +2′·0, apparently a reliable value; at Florence, Ala. +2′·3 a very reliable value; the value +0′·8 for Chicago, Ill. seems too small, though it is certain that the secular change must pass through zero and increase the eastern declinations along our Pacific coast.

Taking a glance at the West Indies and Central American regions, we find at Havana, Cuba, and in Jamaica the *easterly* declination still on the *decrease*, and the dividing region between stations of decreasing and increasing easterly declination, appears to lie somewhere between Panama and Vera Cruz. At the city of Mexico the east declination *increases* about 1′ a year, and at San Blas, Mexico, about 3′; for California, Oregon and Washington, the value formerly assumed by me (in the Coast Survey reports for 1856 and 1859) appears now too small though we possess as yet no precise information. According to Col. Ransom's paper (vol. ii, of the Proceedings of the California Academy of Natural Sciences, 1858–62, San Francisco, 1863) the annual increase of easterly declination for the epoch 1855 is between 2½′ and 4′, though 7′ is said to have been observed in Alameda Co. I feel inclined to assume now an annual increase of 2¾′ along our western coast, 3′ may be taken under the forty-ninth parallel and west of the Rocky Mountains. Higher north, at Sitka, Russian America, the east declination increases about 4′·7 per annum.

It is in contemplation to have special observations made on the Texan and Western Coast for the purpose of a precise determination of the annual change in those localities.

ART. XVIII.—*Observations of Tides at Tahiti, made for the U. S. Coast Survey, under the direction of Captain* JOHN RODGERS, U. S. N. Communicated by Prof. A. D. BACHE, Supt. U. S. Coast Survey.

THE tides at Tahiti have long been known to exhibit the peculiarity of occurring nearly at the same hour of every day, indicating an almost total elimination of the lunar tide.

As far as we know, the tides of no other part of the globe present this extraordinary feature. No explanation fully satisfactory has yet been proposed for this phenomenon.

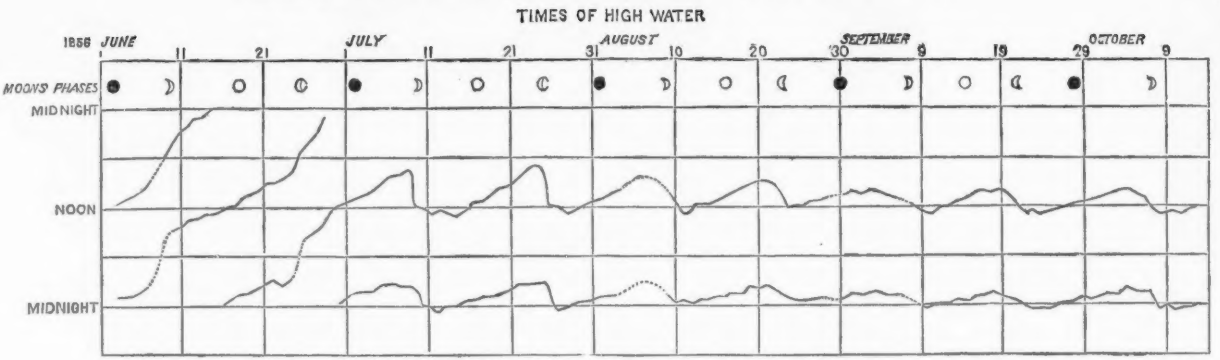
From their bearing on the laws regulating the tides on the North American coast of the Pacific Ocean, accurate tidal observations in central parts of that ocean are a great desideratum, and advantage was therefore taken by the Superintendent of the Coast Survey, of the surveying expedition under the command of Captain John Rodgers, U. S. N., by furnishing him with one of Saxton's self-registering tide-gauges, with the request to set it up at some suitable point.

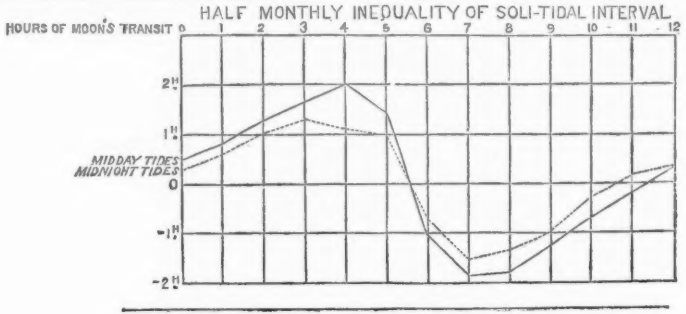
The town of Papeete, on the island of Tahiti, was selected by Captain Rodgers, and the tide-gauge left there under the charge of an intelligent French soldier. The observations began on the 27th of April, 1858, but up to June 2d were so frequently interrupted as to be of little use. After that date, they are nearly complete to October 12th, subsequent to which time no observations have been received.

On the accompanying diagram the mean local time of each high-water has been plotted in such a manner that the abscissæ represent the days of the month, the ordinates the hours of the day. An inspection of the diagram will show that during part of the month of June the tide appears to have followed the general rule, occurring later every day, so that there was a high-water successively at all the hours of the twenty-four. In July, however, the case was quite different. The high-waters occurred at a later hour on successive days, but only until they had reached three or four hours, and, in one case, five, after noon or midnight, when they came back abruptly to the neighborhood of 12, to follow again a similar cycle. This type they preserved to October 12th, when the observations ceased, only the range and the abruptness of the return to an earlier hour becoming lessened.

It will also be remarked that the midnight tides diverge less from that hour than the midday tides from noon. The times of low-water have, as may be expected, similar relations to 6 A. M. and 6 P. M.

TIDAL OBSERVATIONS AT PAPEETE ON THE ISLAND OF TAHITI





Taking the mean of all the observations we find 59 minutes past noon, and 53 minutes past midnight, for the average time of high-water, and 45 minutes past six for the average time of low-water, both morning and night.

The smaller diagram shows the variations from that mean, arranged according to the moon's transit. The curve exhibited might be called the half-monthly inequality in the soli-tidal interval, in analogy to the curve of half-monthly inequality of the luni-tidal interval of ordinary tides.

With regard to the heights, the statements received are not quite precise as to the scale used in the self-registering tide-gauge, and some uncertainty arises from the zero-point having been repeatedly altered, owing to the necessity of using the same paper on the gauge several times. On the best supposition that can be made we find the mean rise and fall to be 0·87 ft. The observations made at the same port, for a few days, by Capt. Sir Edward Belcher, R. N., in 1840 (Phil. Trans., 1843) gave a mean rise and fall of only 0·56 ft. The diurnal inequality is well marked, and the half-monthly inequality regular and normal.

If we examine the variations of the intervals near the time of the summer solstice, we shall find that on the 3d of June or a little after, when the moon's upper transit comes at noon, the intervals for midday tides have their mean value. Then the interval increases rapidly every day as the moon's transits come later, until they come near the middle of the afternoon, when there is a sudden change of 6^h or 8^h in the course of 2 or 3 days, during which time, the tides are so small that their times and intervals cannot be well determined. The high-waters then seem to pass under the influence of the moon's inferior transits, and the intervals are reduced to their minimum values, or become negative. The intervals then increase rapidly again for a considerable part of half a lunation, until they pass again under the action of, and finally under the control of, the moon's superior transits. The same law will be observed to prevail throughout the period of observation, but the inequality rapidly decreases in amount as we depart from the solstice. Similar observations apply *mutatis mutandis* to the midnight tides.

The range of the tides seems to be considerably less near the solstice, than they are near the equinox.

There seem to have been some notable changes in the mean level of the ocean in the month of July.

Hopes are entertained of obtaining more observations, and a supply of paper was forwarded to the U. S. Consul some years ago, but no answer has ever been received. It has been thought advisable therefore to publish the results as far as they have been obtained.

Art. XIX.—*On Prairies;* by A. Fendler.[1]

In my botanical rambles I have seen Prairies, Llanos and Savannahs of different magnitudes and in various stages of progress; and, as I am assured that my suggestions on this subject, although they may not fully coincide with your views, would be received in a kind spirit, I beg to make the following remarks.

The prevalence of moisture, although generally is not always connected directly with a prevalence of forest. For four years I lived on the range of mountains that stretches along the northern coast of Venezuela in lat. 10° N., at an elevation of 6,500 feet above the sea, in the midst of a vast forest. The northern slope of this chain of mountains, from its very crest (7,000–8,000 ft.) down to the margin of the sea, is covered by an immense primeval forest, except in a very few insignificant spots, near some of the seaports, where man has interfered with it. In this mountainous region, from the middle of April to the first of January, hardly a day passes without rain. It is a region enveloped in mist and clouds during most of this time, alternately drizzling, dripping and pouring down, where the temperature rarely ever rises as high as 70° or falls as low as 38°. It is a true "Fern-region," where tree-ferns may be found from 30 to 40 feet high. It is certainly one of the most rainy, moist and humid regions outside of the great equatorial rain-belt. Although the northern or sea-side of this mountain-range is in its whole length covered by forest, savannahs stretch in many places from the very crest down the opposite or southern side, which is constantly exposed to southern or southeastern winds, driving the clouds and mist against it and up along its surface away over the crest. In some localities of the windward side forests alternate with savannahs, but in other localities on the same side, and exposed to the same wet weather, large tracts are entirely bare of forest. The forests, however, do not gain on the savannahs, but from time to time the savannahs gain on the forests by a very simple agent, namely, that of *fire*.

Fire I consider by far the most powerful and the principal agency that gave prairies and savannahs their existence, extending them in the course of time and still busy in extending them. In the prairies of Illinois, Missouri and Texas as well as on the great plains between Missouri and the Rocky mountains, on the llanos of Venezuela and the high savannahs of the mountainous district of the same country, I have seen the same forest-destroyer at work. In the region last named I had the rare opportunity of observing not only the gradual extension of the savannahs,

[1] From a letter to Professor Dana, dated Cambridge, Mass., Dec. 12, 1865.

but also the beginning and the different stages of the conversion of an almost impenetrable primeval forest into a savannah.

I cite the following facts, observed by myself at Colonia Tovar in Venezuela, from an account in the Smithsonian Report for 1857, pages 186–188.

"On the 5th of January I made a botanical excursion to one of the highest mountains of this region, about twelve miles to the east of the colony. The mountain, according to my estimation, may be about 7,800 feet above the level of the sea, and is a kind of central point or knot, from which several rivers, flowing in different directions, take their origin. This mountain is covered by a dense forest, with the exception of a level spot of about half a mile in length and a quarter of a mile in width, which forms a kind of shallow basin, only sparingly covered by a thin coat of short grass and other small plants. * * *

In this excursion I had also an opportunity to form some idea of the vast extent of destruction which was carried into the mountain forest last February by a lucifer match and a thoughtless boy. Over whole tracts of this primeval forest the trees lie dead, one over the other, as if uprooted by a whirlwind, scarcely showing any marks of fire on their trunks. I was struck more than ever with the easy manner in which fire can destroy these dense and humid forests, which, by their shade, preserve a cool and moist atmosphere, and thereby cause the vapors of the adjacent strata of air to condense into clouds, that rest upon them, with little intermission, during nine months in the year. In these high regions the temperature is so low and equable that the vegetable matter which is gathered on the ground between the trees is decomposed very incompletely and very slowly. It forms a stratum of loose half-decomposed matter, in some places two to three feet thick, which, in the rainy season, like an immense layer of sponge filled with water, feeds and supplies the rivulets and rivers *gradually*. In the midst of the dry season this layer becomes sometimes dry enough to burn, when kindled, with but little flame, and more like tinder, spreading in all directions.

In this way the fire extends until met by a river or a road, or some other obstacle. The subsoil which underlies the spongy stratum on these mountains is also very shallow and resting on hard rocks. The roots of the trees, therefore, do not go down very deep, but extend more in a horizontal direction. When the spongy layer, with the smaller roots, are burnt, the trees lose their hold entirely and fall, one over the other, in all directions. They die less from being burnt than from being uprooted. Many different kinds of tall reeds soon take the place of the trees. In a few years these reeds exclude everything else. The fertile mould that may perhaps have escaped destruction by fire is by and by carried down the declivities by the frequent rains. The region, no longer shaded by high trees, becomes dry. Subsequent conflagrations of adjacent savannahs, which are intentionally set on fire to procure a new growth of young grass, take hold of the reeds of the ruined forest, until, by the repeated attacks of these fires, the roots of the reeds can stand it no longer, and the smaller grasses, interspersed with a few other plants, take their places.

On the road from the colony to Caracas we pass through a region in which this process is going on; the reeds giving gradually way to the smaller grasses. Here the great number of half-burnt yet standing trunks of the wax palm tell plainly enough that there existed not long ago a dense and humid forest, in which they luxuriated in all their beauty, for these palms are never found, in their natural state, growing in any other but humid forests. Here they stand isolated in the midst of reeds. Most of them have died already, but many linger yet in a dying condition, until their last green leaf has turned brown, and then they stand like tall and slender pillars, the mournful remnants of a once stately forest."

The contrast with regard to forests in the above mentioned two mountain slopes (the northern and southern) is easily accounted for. The strong and ever restless southern and southeastern breezes sweep only the southern side of the mountains in their course up to the crest. Leaving the latter, they go on horizontally through the aërial ocean and never touch the surface of the northern slope, where calms prevail. The fire being fanned by the southern current, ascends the windward side of the mountain, but on reaching the crest is abandoned by the breeze; it can make no further progress and dies out.

I may also remark, that no instance ever came to my knowledge in which a high prairie (savannah) once *firmly established* was encroached on by the extension of a forest, no matter how humid the region may have been. But as long as the loose mould in a partially burnt forest has not been destroyed by fire or swept down by rain, so long is there a chance for the recovery of that forest in a moist region, if no intruding weeds are in the neighborhood, and further attacks of fire excluded.

Although the prevalence of moisture and forest, and that of dryness and prairie generally go together, we are not warranted to conclude that a prairie is the effect of dryness alone, for it can be shown in many instances that dryness of a region is the effect of prairies. The sun, heating the surface of the earth, thereby raising heated columns of air, disperses clouds and fogs, as may often be seen at Colonia Tovar with clouds moving across the cultivated valley, which lies between two nearly parallel mountain-ridges heavily timbered. The clouds as they come moving on from the southern range vanish as soon as they reach the cleared and cultivated area, and form again by condensation on drawing near the opposite or northern range.

New-made land offers a good chance for the establishment of a forest. If we believe in geology we cannot but admit that, at one time or other, far back in the history of our planet, either anterior to, or cotemporaneous with, the great Carboniferous era, a humid, rainy, cloudy climate of a more equable temperature, and resembling in many respects that of the equatorial

low regions of South America, prevailed all over the continent up to high latitudes. Here, then, all the conditions for the existence of a vast continuous forest all over the land are given, and we are entitled to infer that at that period one immense mass of forest spread not only over all the land above water, but also through swamps and other shallow overflowed places. All the grassy plains, prairies and high savannahs must have originated since. Suppose the climate to have changed gradually in later periods, the ground elevated in some places, clouds dispersed and the atmosphere become drier. In this case a majority of the trees will, no doubt, die off gradually; but as long as the ground underneath is shaded, and covered by vegetable mould of a loose texture, resulting from the accumulation of decayed leaves, tree-seeds will germinate, new varieties and new species, better adapted to the new order of things, will in their struggle for existence make their appearance, and still there will be a forest although in a different garment.

Grass cannot well succeed in dense shady forests. In the extensive prairies of western Texas I have seen isolated clumps of timber like little oases in a desert, some not more than 200 feet in diameter, effectually resisting not only the encroaching attacks of the prairie-grass, but even those of the prairie-fires, and this in a pretty dry region subject to long continued droughts. Their margins are so dense with underbrush that in most cases not even a large sized dog could penetrate them.

Let the climate of a mountain region have only drought of two or three months' duration, no matter how moist, damp and wet it may be the remaining nine or ten months, and it will be no difficult task to convert by fire the forest covered slopes into savannahs. In a drier climate, of course, this conversion of forest into prairie by the agency of fire can be accomplished much faster.

On the other, hand in regions perpetually moist and wet the forests are safe enough against all encroachments from prairies, because fire can do no mischief here. But also in comparatively *dry* climates the forest will be safe against the intrusion of prairies, if the trees stand on a deep fertile soil, where their roots may go down deep and support the tree from falling, and where the trees have a tendency to sprout from their roots; for it would take many repeated firings of the undergrowth to lay that ground open to the baking influence of the sun.

Again, at Santa Fe, New Mexico, the atmosphere is so exceedingly dry that, with the exception of the sides of a deep, narrow mountain-valley, through which a creek flows, I have never seen *dew*. The dry, gravelly soil is for the greater part covered with forests of Coniferæ, not only on the higher mountains, but also on the low hills. The sterile soil is so dry during summer and

autumn, that the thin grass, although sprouting and growing during spring, has no power of spreading. In winter the ground is generally covered with a considerable layer of snow.

That on sloping land, elevated ridges, mountains, etc., the forest can be changed into prairies or savannahs more readily than in other situations having the same degree of humidity, is easily accounted for. The thin layer of soil in such localities rests mostly on layers of rocks; the tap-roots of trees cannot penetrate to any considerable depth, and the tree is rather loosely fixed to the ground. Fire can easily undermine it, so that it may be prostrated not only by moderate breezes, but by its own weight. When fallen, its shade no longer protects the binding rootlets of thousands of cryptogamic and other plants delighting in shade; they wither and die. The fertile layer of mould is now open to the attacks of sun and rain. By degrees it is washed down the declivities, leaving the more tenacious clay behind, on which reeds and grass spread and with their creeping roots form a dense matting in which no tree-seeds can germinate.

All the moist and forest-covered places and valleys on the lower parts of Tahiti and elsewhere, cited as exceptions, are those by which, on account of their moist surface, the progress of fire that once destroyed the forests on the drier slopes and convex localities, was arrested.

ART. XX.—*A new method of Meteorological comparison, with three illustrative Tables;*[1] by PLINY EARLE CHASE, M.A., S.P.A.S.

[Concluded from p. 95.]

IN the regions of variable winds, it can hardly be supposed that the correspondence between changes of wind and of declination should be so marked as in the torrid zone. I find, however, upon tabulating about two thousand of the Toronto Observations, that there are some indications of a similar character to those in the St. Helena Table; but they are, comparatively, so slight, that another form of comparison has given results which are more satisfactory to my own mind.[2]

[1] From the Proceedings of the American Philosophical Society, vol. x, pp. 161–166.

[2] M. Kaemtz (Meteorology, Walker's translation, p. 451) states that "the dip depends, like the height of the barometer, on the direction of the wind and on temperature." This is the earliest intimation I have yet discovered, which can be possibly construed as either *implying* or tending to demonstrate a direct correlation between weight and magnetism. The resemblance between the curves of wind-force and magnetic vertical force, would naturally lead one to look to the dip rather than to the declination, for the most striking evidence of the magnetic effects of direction of the wind.

According to my several hypotheses, the magnetic impulses are transmitted with a velocity analogous to that of light, and the position of the needle at any moment is dependent upon the combined action of local and cosmical forces, the former producing continual agitations of short period, and the latter largely preponderating in the daily means. On the other hand, the barometric and other atmospheric changes, in consequence of greater inertia, are more obedient to cumulative influences that have a limited local origin, and less affected by sudden violent disturbances. It seems reasonable, therefore, to suppose that the oscillations about the mean magnetic values should differ, in duration and in other respects, from those about the thermal and barometric means. If their mutual relations are much obscured in consequence of this difference, any lingering evidences of inter-dependence that we may find may be entitled to great weight.

Taking Toronto as a typical station of average, and St. Helena as one of minimum accidental magnetic disturbance, I first deduced from three years' observations at each place (1843, '44, '45 at Toronto; 1843, '45, '46 at St. Helena; the observations of 1844 being comparatively incomplete), the average duration of the fluctuations of each element. I found the following mean lengths of an oscillation, measuring from the maximum of one wave to the maximum of the succeeding wave (B representing the barometer; T, thermometer; H, horizontal force; V, vertical force; D, declination).

	B.	T.	H.	V.	D.
Toronto, . .	3·98 days.	3·93 days.	4·54 days.	4·31 days.	3·10 days.
St. Helena,	4·38 "	3·67 "	3·82 "	4·46 "	3·35 "

The mean wave-periods, taking the duration of the alternate variations above and below the monthly means, were as follows:

	B.	T.	H.	V.	D.
Toronto, . .	2·91 days.	3·70 days.	4·55 days.	4 78 days.	2·32 days.
St. Helena,	3·76 "	3·86 "	4·34 "	5 51 "	3·27 "

By marking with the signs + and − the excess or deficiency of each daily mean, the monthly mean being assumed as the standard of comparison, I obtained the data for Tables I and II. The columns headed C contain the number of observations that present a correspondence (excess in one element accompanying excess in the other, and *vice versâ*), and those headed O give the number of instances in which there was an opposition of signs between the daily means indicated by the heading of each double column.

Table I.

Correlations of Temperature, Gravity, and Magnetism, in the Daily Means at Toronto.

	B. & T.		H. & V.		B. & H.		T. & H.		B. & V.		T. & V.		B. & D.		T. & D.	
	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.
	9	17	20	1	16	8	2	22	14	8	2	20	9	15	11	13
Jan.	5	22	..	..	18	9	6	21	..	..	..	..	14	13	10	17
	11	16	18	9	15	12	8	19	14	13	8	19	9	18	15	12
	11	13	8	13	11	11	13	8	14	10	2	22	14	10	11	13
Feb.	9	16	16	2	20	5	10	15	15	3	6	12	16	9	14	11
	6	18	20	4	16	8	6	18	18	6	2	22	15	8	4	19
	10	17	13	14	6	21	17	10	16	11	9	18	13	12	9	16
March.	12	14	18	8	10	16	10	16	12	14	4	22	16	10	10	16
	16	10	20	5	9	16	6	19	8	17	5	20	13	11	12	12
	9	15	4	20	10	14	18	6	18	6	4	20	19	5	11	13
April.	8	17	16	9	13	12	12	13	13	12	5	20	14	11	11	14
	14	12	26	0	12	14	2	24	12	14	2	24	14	12	6	20
	8	19	5	22	10	17	15	12	18	9	5	22	11	16	12	15
May.	7	20	19	7	16	10	6	20	16	11	6	21	17	10	9	18
	7	20	23	4	15	12	7	20	18	9	6	21	13	14	14	13
	11	15	4	22	13	13	20	6	13	13	2	24	12	14	13	13
June.	8	17	17	8	20	5	7	18	16	9	1	24	14	11	15	10
	6	19	14	10	20	5	5	20	16	8	9	15	11	14	14	11
	8	19	8	18	10	17	15	12	21	6	6	21	13	14	12	15
July.	9	18	14	13	17	10	5	22	10	17	10	17	19	8	11	16
	10	17	22	5	13	14	6	21	14	13	5	22	19	8	12	15
	11	16	14	13	17	10	11	16	20	7	6	21	16	11	8	19
August.	15	12	21	6	14	13	8	19	10	17	10	17	10	17	10	17
	8	18	8	18	18	8	6	20	8	18	22	4	16	10	12	14
	9	17	22	4	13	13	4	22	15	11	2	24	16	10	11	15
Sept.	9	16	22	3	17	8	3	22	18	7	2	23	12	13	12	13
	8	18	22	4	16	10	6	20	18	8	4	22	12	14	12	14
	8	18	7	4	15	9	3	21	6	6	3	9	13	13	12	14
Oct.	7	20	18	9	13	14	9	18	18	9	4	23	15	12	11	16
	4	23	23	4	20	7	7	20	18	9	5	22	17	10	10	17
	7	19	..	..	15	11	8	18	..	..	..	..	16	10	11	15
Nov.	13	13	18	8	18	8	7	19	15	11	6	20	15	11	8	18
	6	19	22	3	19	6	2	23	18	7	3	22	12	13	9	16
	12	13	..	..	18	7	9	16	..	..	..	..	15	10	10	15
Dec.	10	15	20	5	14	11	3	22	11	14	4	21	13	11	7	18
	9	17	22	4	16	10	5	21	16	10	1	25	13	13	8	18
1843.	113	198	105	131	154	151	135	169	155	87	41	201	167	140	131	176
1844.	112	200	199	78	190	121	86	225	154	124	58	220	175	136	128	184
1845.	105	207	240	70	189	122	66	245	178	132	72	238	164	145	128	181
Total.	330	605	544	279	533	394	287	639	487	343	171	659	506	421	387	541

TABLE II.

Correlations of Temperature, Gravity, and Magnetism, in the Daily Means at St. Helena.

	B. & T.		H. & V.		B. & H.		T. & H.		B. & V.		T. & V.		B. & D.		T. & D.	
	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.
	11	15	14	8	14	12	7	19	15	7	6	16	12	13	14	11
Jan.	17	10	14	12	11	16	10	17	13	14	11	16	13	14	11	16
	7	19	8	19	23	4	5	22	9	18	15	11	17	10	12	14
	13	11	15	8	12	12	9	15	8	15	5	18	12	12	13	11
Feb.	16	8	11	11	16	8	15	9	13	9	13	9	16	8	16	8
	10	14	12	12	12	12	4	20	8	16	8	16	9	15	11	13
	12	15	10	17	15	12	7	20	9	18	18	9	15	12	14	13
March.	11	14	15	10	8	17	16	9	14	11	16	9	13	12	15	10
	12	14	17	9	10	16	6	20	11	15	15	11	13	13	13	13
	21	4	4	20	10	15	10	15	19	5	19	5	13	12	15	10
April.	16	10	18	7	14	11	17	8	13	13	17	9	15	11	13	13
	9	16	3	16	12	13	12	13	8	11	15	4	10	15	10	15
	10	17	5	21	15	12	8	19	7	19	19	7	19	8	12	15
May.	10	17	6	20	20	7	5	22	7	19	19	7	12	15	17	10
	10	16	6	18	14	11	6	19	7	18	22	3	13	13	9	17
	10	16	5	20	21	5	11	15	10	15	19	6	15	11	15	11
June.	14	11	4	21	13	12	4	21	12	13	19	6	11	14	8	17
	12	14	8	15	18	8	8	18	10	13	10	13	15	11	19	7
	9	17	5	19	16	9	9	16	7	18	16	9	13	13	14	12
July.	12	15	14	13	14	13	9	18	13	14	18	9	14	13	17	10
	10	17	7	20	19	8	6	21	13	14	22	5	14	13	11	16
	5	22	3	23	20	7	6	21	7	19	20	6	16	11	10	17
August.	18	8	13	13	11	15	7	19	12	14	18	8	16	10	12	14
	8	18	14	11	17	9	11	15	7	18	17	8	12	13	15	10
	12	14	10	14	10	16	6	20	14	10	16	8	20	6	16	10
Sept.	15	11	11	15	9	17	8	18	14	12	19	7	12	14	7	19
	14	12	11	15	6	20	13	13	6	20	16	10	10	15	14	11
	16	10	18	6	10	16	6	20	11	13	4	20	18	8	14	12
Oct.	12	15	9	17	18	9	9	18	11	15	16	10	12	15	15	12
	11	16	9	18	16	11	12	15	16	11	20	7	16	10	12	24
	10	16	10	12	16	10	4	22	7	15	13	9	13	13	11	15
Nov.	12	13	7	18	14	11	9	16	10	15	15	10	15	10	12	13
	14	11	11	15	15	10	12	13	13	12	14	11	13	12	16	10
	9	16	17	8	18	7	8	17	12	13	8	17	16	8	11	13
Dec.	18	8	12	14	13	13	13	13	15	11	13	13	14	12	12	14
	14	11	15	10	7	18	6	19	7	18	12	13	7	17	8	16
1843.	138	173	116	176	177	133	91	219	126	167	163	130	182	127	159	150
1845.	171	140	134	171	161	149	122	188	147	160	194	113	163	148	155	156
1846.	131	178	121	178	169	140	101	207	115	184	186	112	149	157	150	156
Total,	440	491	371	525	507	422	314	614	388	511	543	355	494	432	464	462

Tabulating similarly the magnetic observations for one or two days prior and subsequent to the several thermometric and barometric fluctuations, I find indications of a continued action, which is paralleled by the ocean swell that remains after the subsidence of the winds by which the waves were originally excited.

In order to ascertain whether the correspondence, which is thus shown to exist between the daily means of the different elements, can also be traced in the hourly means, I noted the character of the undulations for several entire weeks, selecting observations at different seasons, in such a manner as I thought would give a pretty correct approximation to the average of each of three years. Considering the increasing waves as positive and the decreasing as negative, I obtained the data which are summarily detailed in Table III.

TABLE III.

Correlations of Temperature, Gravity, and Magnetism, in the Hourly Means at Toronto and St. Helena.

	B. & T.		H. & V.		B. & H.		T. & H.		B. & V.		T. & V.		V. & D.		T. & D.	
	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O
TORONTO.																
1st year.	197	242	208	188	212	232	227	232	201	176	162	229	225	211	195	260
2d "	202	234	170	202	246	217	197	234	188	173	165	192	225	217	189	238
3d "	191	232	171	128	218	211	192	259	155	125	120	172	230	202	200	248
Total,	590	708	549	518	676	660	616	725	544	474	447	593	680	630	584	746
ST. HELENA.																
1st year.	198	227	125	179	231	200	217	187	129	183	172	131	225	205	198	204
2d "	199	232	121	203	247	189	250	164	138	196	173	145	248	174	189	211
3d "	190	203	143	182	244	194	249	159	142	194	187	126	220	199	181	210
Total,	587	662	389	564	722	583	716	510	409	573	532	402	693	578	568	625

This triple comparison exhibits, in a very conclusive and satisfactory manner, a connection between temperature, gravity, and magnetic force, which, taken in conjunction with my previously adduced evidences of rotation-tides, appears sufficient to adequately explain all of the well-established normal meteorological fluctuations, and to give a clearer insight into the true meaning and value of the various partial relations which have been previously ascertained or surmised.

It is interesting, especially if we incline to adopt the common hypothesis that the barometric fluctuations are all owing, mainly, if not exclusively, to thermal disturbances, to observe that the magnetic force is more directly and powerfully affected by variations of temperature than the barometric pressure; and that at St. Helena the relation of the barometric to the thermometric movements is less marked than those of either the horizontal or vertical force to the fluctuations of gravity and of temperature. The relative preponderance of the rotation tide over the temperature tide at St. Helena (as shown by the barometer), is an additional evidence of the eligibility of that station for observing the correspondence between the fluctuations of magnetic force and the disturbances of gravitation.

In comparing the St. Helena and Toronto totals, five of the columns exhibit an opposition of relations, such as might have been anticipated, because the laws of equilibrium require that a disturbed "line of force" in one portion of the globe should be counterbalanced by an opposite line in another portion.

The analogies that have been pointed out by Sir David Brewster and Sir John Herschel between the curves of terrestrial magnetism and those of the polarization of skylight, are a natural consequence of the mechanical laws which we have been considering. The special maximum which Herschel finds it so difficult to account for (Meteorology, p. 230) may be explained by the centripetal reaction against the centrifugal thermal and other solar disturbances, which is a maximum at 90° from the sun.

ART. XXI.—*On Cephalization;* No. IV: *Explanations drawn out by the Statements of an Objector;* by JAMES D. DANA.[1]

IN a paper published in the third volume of the Proceedings of the Entomological Society of Philadelphia, Mr. B. D. Walsh discusses the subject of the classification of Insects as based on the principle of cephalization, and criticises, not my views, but his own misconceptions of them.[2] As others may have fallen into similar errors, notwithstanding the long explanations which have been presented, I briefly notice here some of the points in his paper.

1. Our objector says (p. 238) that "as originally propounded by him [Mr. Dana] in Crustacea, cephalization consists in 'the transfer of the anterior members of the thorax to the cephalic series' (Sill. Jour., vol. xxxv, p. 66), or in other words in *legs* being converted into *head-organs.*"

In the first place, our expositor, while claiming to cite what was "originally propounded" by me, had not seen my *original* memoir published in 1852[3] in the Report on Crustacea, and in 1856 in this Journal, and refers to no paper earlier than that of 1863.

In the second place, he finds in the paper which he does cite what neither that paper, nor any other that I have written, contains. I have nowhere said that cephalization *consists* in such a

[1] For number I, of this series, see this Journal, xxxvi, 321, Nov. 1863; number II, xxxvii, 10, Jan. 1864; number III, xxxvii, 157, March, 1864.

[2] On certain Entomological speculations of the New England School of Naturalists, by B. D. WALSH, M.A., Proc. Entomolog. Soc., iii, 207. The writers of the "New England School" here particularly criticised are Prof. Agassiz and Prof. Dana; and, incidentally, A. S. Packard, Jr., some passages of a paper of his having been cited by the latter.

[3] Not 1855, as stated in this Journal, xxxvi, 321.

transfer of members. The statement would be wholly at variance with the very idea of cephalization. What I have asserted is this: that variation in grade of cephalization is *manifested* in the structure by the transfer referred to, and by this as only *one among many methods.*

I have argued that since animals have a head as their grand characteristic feature, and a cephalic nervous mass as the fundamental element of the head and the prime center of force in the organism, exaltation and concentration anteriorly of the life-forces mark a high grade of cephalization; and relaxation or decentralization, and an enfeebling of the same, with a consequent spreading posteriorly or away from the cephalic extremity, indicate a low grade of cephalization. I have also said that these conditions of the life-forces of the individual, that is, of the organizing and working forces, should necessarily be apparent, and are in fact apparent, in the structure of the organism, the resultant of the forces. I have shown that concentration anteriorly, with exaltation of the cephalic extremity, is manifested not merely in the transfer of members to the cephalic series (thereby enlarging the sphere of the head), but also in the form and structure of the head,—in the form and condition of the organs of the senses—of the organs of the mouth—of the successive pairs of legs—of the abdomen—of the abdominal appendages; and in my later memoirs I have still more widely extended the list of characteristics that indicate grade of cephalization.

The laws of cephalization act conjointly with another principle in animal life:—that of the *oppositeness subsisting between the cephalic or anterior and the posterior extremities of the animal structure*, which is a kind of antero-posterior or fore-and-aft polarity. This oppositeness or polarity is *up-and-down* in the plant, and *fore-and-aft* in the animal. The fore-and-aft becomes strictly up-and-down *in position* in one animal alone—Man; and this by elevating heavenward the cephalic extremity, not by a change of the axis of symmetry to that of the plant. (See this Jour., xxxvi, 351.)

In view of the total misapprehension of this subject by our entomological critic, I may be excused for citing additional explanations from an article written for a popular magazine, even if they are essentially a repetition of what is contained in my former papers.

"As the head is the seat of power in an animal, it is natural that among species rank should be marked by means of variations in the structure of the head; and not only by variations in its structure, but also in the extent to which the rest of the body directly contributes, by its members, to the uses or purposes of the head. *Cephalization* is, then, simply domination of the head—cephalic domination—in an animal, as manifested in the structure; and any *degree* of it depends on the grade of power of the

cephalic center, and the degree of subordination to it in the structure. The following are some of the ways or methods in which it is manifested.

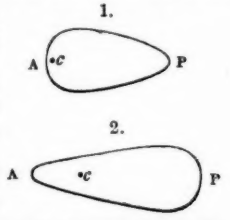
(1.) With *superior* cephalization, that is, as species rise in grade or rank, more and more of the anterior part of the body, or of its members, renders service to the head; with *inferior*, less and less.

(2.) With *superior* cephalization, the structure of the head, or of the anterior portion of the body, becomes more and more compacted, perfected, and condensed or abbreviated; with *inferior*, the same portion becomes more and more lax in its parts or loosely put together, and imperfect in the parts or members themselves; and, at the same time, the whole is more and more elongated, and spaced out or enlarged.

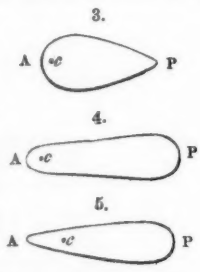
(3.) With *superior* cephalization, the posterior portion of the body becomes more and more compacted, or firmly put together and abbreviated; that is, as concentration goes on *anteriorly*, there is abbreviation *posteriorly*. Even the tail shows grade; for great length, or size, or functional importance is actually a mark of inferior grade, other things being equal.

(4.) With *inferior* cephalization, there is not only a less and less concentrated or compacted and perfected state of the whole structure, before and behind, but, in its lower stages, the degradation of the structure extends to an absence of essential parts, as *teeth*, *members*, *senses*; and often, also, to a gross enlargement of the body beyond the size which the system of life within can properly wield, and in this case the body is stupid and sluggish."

The question as to the condition of the life-forces thus passes from the sphere of speculation to one of direct observation. A *Lion*, for example, exhibits to the eye the high degree of cephalization of its structure by its strength anteriorly, or that of its head and fore-limbs, and the correlate form and structure of these and other parts of the body; and a *Whale* manifests its low degree by its degraded head and senses, its feeble limbs partly obsolete, and the immense size and strength of the tail; and this is so obvious, that the muscular or motorial force of the two might be sufficiently well represented by the annexed figures: figure 1 corresponding to that of the Lion, and 2, to that of the Right Whale, A being the anterior or cephalic extremity and P the posterior or caudal extremity. The figures give a faint idea of what is meant by *cephalization* and *decephalization*. If the sensorial forces of the Lion were taken into consideration, the contrast between the two would be still greater. *c* is the position of the prime systemic center; its remoteness from the front margin in the Right Whale, (figure 2) is one of the marks of the extreme decephalization of the structure. (See on Cephalization, No. III.) The arrangement of the muscular force in different Herbivores might be represented by figures intermediate between 1 and 2.



The following figures serve in a similar rude way to illustrate the condition of the force in the three subdivisions of Decapod Crustaceans; figure 3, in the Crab, which has the abdomen (the part so large in the lobster) almost wanting and very feeble, and the systemic center (*c*) very close to the front margin; fig. 4, in the Shrimp which has the body prolonged before and behind, but especially in the latter direction, the posterior portion or abdomen being of great size and powerful as an organ of motion; fig. 5, in certain species of the Squilla group, in which the cephalothorax is weak, its appendages feeble, the abdomen 2 or 3 times as long as the anterior part of the body and relatively to the cephalothorax far more powerful than in the Lobster or Shrimp. Other classes of animals afford similar illustrations.



There are probably no characters connected with the structure, growth and habits of an animal that have not something to reveal with reference to grade, under this principle of cephalization. To read the truth, especially among the lower subdivisions of a class, the families, genera, species, may often require profound study, and even a higher stage of science than the world has now attained to. But the necessity of profound study, when knowledge below the surface is sought for, is not peculiar to this department of nature.

I repeat, then—cephalization does not "consist in a transfer of members" one way or another, but is *manifested* by the whole animal structure within and without.

2. Our objector says that this character of cephalization "really appears to be of high systematic value in Crustacea"; but, as the neuration of the wings is a good characteristic in one group of Insects and not in an another, so it is not necessarily good in other animals.

This comparison of the principle of cephalization, the origin of a host of characteristics, with the single superficial one *from the neuration of the wings*, is in accordance with the misquotation making cephalization to consist in a transfer of members, &c.

The laws of cephalization pertain to the elemental forces of the organism, or the fundamental nature of animal life, as much as the laws of attraction to the fundamental nature of a molecule; and, therefore, if true of one branch of the Animal Kingdom, they must be true of all. Yet the exhibition of these laws in the structure will be widely different, as the structures themselves are various in character. They cannot be precisely the same in footless Worms as in Crustaceans; or in Crustaceans as in In-

sects; or in Insects as in Mammals; although the grand fundamental principle at the basis of the organism is the same in each.

3. Our objector observes again, with like misconception of the subject, that as "the conversion of the front wings into elytra amounts to a decephalization," "instead of classing Hemiptera as inferior to Coleoptera and Orthoptera to Hemiptera, we ought to adopt exactly the opposite arrangement. For Coleoptera have the front wings entirely elytriform, Hemiptera (Heteroptera) only about one-half elytriform, and Orthoptera scarcely or but slightly elytriform. Those groups, therefore, according to Dana's own principle ought to stand, 1, Orthoptera, 2, Hemiptera, 3, Coleoptera, instead of the reverse."

Thus, Mr. Walsh sets up his man of straw, and combats it with great success.

"Dana's own principle," above announced and demolished, is not to be found in any of Dana's own writings. The fact of the fore-wings being coriaceous wholly, in part, or not at all, has no bearing whatever on the question; this is a mere external characteristic, of no dynamical value, like most of the characteristics appealed to by ordinary systematists. I expressly state that the true distinction depends on the *posterior* wings being the main flying-wings; I say, further, that the fore-wings may be used for flying, and still, if the hinder wings are the more powerful, the insects are *metasthenic*, and have the characteristic of the inferior or Coleopteroid division.

The segment of the body bearing the stronger flying organs in these metasthenic species (Coleoptera, Hemiptera, Orthoptera) is one *posterior* to the same in the higher prosthenic species (Hymenopters, &c.); and the fact that the force is consequently, more posterior among the body segments, and among the nervous ganglions, is hence one of direct observation, and not a hypothetical inference. The terms *prosthenic* and *metasthenic* bear the profounder meaning of cephalization in their composition.

There being two sthenic characters of acknowledged value based on the limbs, one on the *wings*, and the other on the *legs*, it is asked, why the former should be made to have the precedence in classification. Simply because they have the precedence *in fact*. The species of the grand division of Coleopters are *throughout metasthenic as regards the wings;* that is, the posterior wings are the only flying wings or, at least, the stronger, in all the species; and this is true also, of the Hemipters and Orthopters: while they are not all metasthenic as regards the legs; for under these groups there are subordinate divisions which include among the species both those that are *prosthenic* and those that are *metasthenic as regards the legs*. The latter distinction is, therefore, as a matter of fact, of limited importance or compre-

hensiveness compared with the former. But this point is sufficiently illustrated in my article on the classification of Insects and requires no additional explanation here.

4. Our objector says that the position of the wings in the Dipters is half a segment nearer the head than that of the anterior pair in the Hymenopters, and that *therefore the Dipters ought to stand first in the system.* But he errs from failing to note that the wings in Dipters do not pertain to a *more anterior segment*, or nervous ganglion (center of force), than the fore-wings in Hymenopters, but, on the contrary, to the very same; whence, there is no parallelism between this difference and that separating the Hymenopters and Coleopters. The difference of position alluded to has, consequently, little or no dynamical value, and little or no weight in a classification based on cephalization.

5. Our objector applies his mistaken definition of cephalization further, and argues as follows:

"If we apply the principle of Cephalization in its original signification to Insects, we shall find that there are certain families and genera, e. g. in Orthoptera *Mantidæ*, in Neuroptera *Mantispa*, in Heteroptera *Myodocha*, *Phymata*, *Macrocephalus*, *Syrtis*, *Reduviidæ* and *Nepidæ*, and in Diptera *Hemerodromia*, which have what are commonly known as raptorial front legs; in other words the front legs are used, not as *legs* but as *arms* to catch their prey with. In other species, e. g. the dipterous *Calobata antennæpes* Say, which takes its name from that peculiarity, and in many Nemocerous Diptera, the front legs are not used at all for locomotive purposes, but are elevated in the air and vibrated after the fashion of antennæ. Here therefore it is strictly true that "the anterior members of the thorax are transferred to the cephalic series;" and if, as Prof. Dana maintains, the cephalization of the anterior pair of limbs in Man, or in other words the conversion of his front limbs into arms, "places Man apart from the whole series of Mammals" (Sill. Journ., vol. xxxv, p. 68), then by parity of reasoning, if the principle of cephalization is universally applicable, all the above-mentioned families and genera of Insects ought to be placed in a group by themselves."

The prehensile or raptorial modification of the anterior limbs and the transfer of members to the cephalic series are here mixed up, although both characteristics are the subject of extended explanations in my paper; and hence our objector's remarkable result.

I have stated that there were but three examples of the *transfer of members to the cephalic series* in the whole animal kingdom—the Entromostracans or degradational Crustaceans excluded, in which the examples are not well-defined. One is that from Tetradecapods to Decapods, the *four anterior* of the *fourteen* feet in the former being mouth-organs in the lat-

ter; the *second* is that from Spiders to Insects (or Octapods to Hexapods), the two anterior feet in the former being mouth-organs in the latter. One of these cases occurs between the two higher divisions of *aereal* Articulates or Insecteans; and the other two between the two higher divisions of the foot-bearing *aquatic* Articulates or *Crustaceans*.

The *third* case is that from Quadrupeds to Man, the *two* anterior feet in the former being in man taken completely out of the locomotive series and given up to the cephalic series, to which series, moreover, they *structurally* belong.

Now there are numerous Tetradecapods with *prehensile* fore-legs, but they are no less Tetradecapods in type of structure and all their relations. These prehensile legs aid in capturing food; but they are no more part of the cephalic series than are the prehensile fore-feet of a squirrel. There are Decapods with prehensile fore-legs, which are none the less Decapods; and there are also inferior macrural species (certain shrimp-like kinds) which have the four outer mouth-organs foot-like in size and function, so that they have as many feet as the Tetradecapods; and yet they are Decapods in type of structure, and show no true approximation to the Tetradecapod type.

Among Quadrupeds, the fore-feet of the Carnivores are prehensile, and those of the Squirrels and Monkeys quite perfectly so; and yet these limbs are part of the locomotive series. Man stands alone among Mammals in having the fore-limbs, not only prehensile, but out of the inferior series, the posterior pair being the sole locomotive organs.

The question of the exact parallelism of this last of the three cases with the preceding two admits of arguments on both sides. But whichever way decided, it does not affect in the slightest degree our deductions under the principle of cephalization. It touches only one single argument on the question whether Man constitutes by himself a separate Order among Mammals, and this, in our view, not seriously. All must admit, whatever his views of the question, that this ennobling of the fore-limbs is one mark of that preëminence of cephalization which belongs to Man.

6. The necessity of an exact balancing of all characteristics bearing on grade, in order to arrive at correct results, is too obvious for an argument. If the inferior criterion is in any case made the superior one, only absurdities are reached. Our objector affords examples of this kind of error. Observing that narrow limits of variation, and a less tendency to run into bizarre forms, are set down as generally characteristic of a superior group, and as part of the evidence of the superiority of

the Hymenopters, he remarks that the Fleas are far more uniform in shape and size than the Hymenopters, and therefore, according to the criterion mentioned, ought to be placed *first* among the Apipens; apparently unaware that in this bit of logic the criterion referred to is made *superior* to all others, or the most decisive of grade, and not perceiving, therefore, that the *reductio ad absurdum*, intended for the principle criticised, attaches to the critic himself. Again, by a similar misuse of the criterion connected with prehensile anterior limbs, and additional misunderstandings already alluded to, he arrives at other absurdities. In the same way he might assume that, because great length of antennæ is one of the marks of low grade,—the Macrurans (Lobsters, Shrimps, &c.,) showing by this character, as I have stated, their inferiority to Brachyurans (Crabs),—therefore Insects ought to be arranged according to length of antennæ; which would of course make very heterogeneous assemblages. Or he might next make abdomens or tails the grand criterion, (this characteristic being also set down as a mark of grade), with a like result. By thus assuming successively that each criterion is superior in value to the others, all may be run into the ground; a feat of no great prowess in logic or science.

While long antennæ and long abdomens are among the marks of that decentralization or decephalization which distinguishes the Macrurans from the Crabs, some of the higher Macrurans have, relatively to size of body, longer antennæ than the lower; and there are hundreds of Tetradecapods and Entomostracans, still inferior species, that have relatively to length of body, far shorter antennæ, and shorter abdomens too, than the Macrurans. There are, in all such cases, characters to be considered of higher value before we come down to that level where length of antennæ, or of abdomen, is decisive as a mark of grade.

7. As Nature is yet an unfathomed deep, our systems must have their imperfections and uncertainties, and we our difficulties in applying principles that have been ascertained. Examples of such difficulties from the subject of cephalization have been alluded to in the preceding remarks; and here is another.

Large size in species, as all know, is sometimes a mark of superior grade. The fact is pressed upon our attention by familiar facts, as well as by the general relations in mean size of high and low types among animals. Vertebrates are larger than Insects or Worms, Insects than Infusoria, Beasts than Birds, etc.

But, again, large size is sometimes, also, accordant with, and a mark of, inferior grade. Man is smaller than his inferior the Lion; the Lion is smaller than its inferior the Hippopotamus; the Hippopotamus than its inferior the Whale; the Crab than its inferior the Lobster; the Echinus than its inferior a large

Medusa; and so on. Now it may be urged, against the system of classification proposed, that size sometimes means one thing, and sometimes the reverse, and there is here manifest indefiniteness and a chance for indefinite assumptions. Or, the charge may be made with more point, and much less truth, as follows: "Because great size is correlated with superiority in *Crustacea*, you [Mr. Dana] infer that it is so correlated everywhere throughout the Animal Kingdom; and when, as nobody can fail soon to do, you meet with examples where facts contradict your theory, you get over the difficulty by assuming gratuitously that size is there due only to what you call 'vegetative enlargement.' As I cannot find that you have anywhere laid down any definite rules by which this vegetative enlargement is to be distinguished from the normal enlargement, the distinction appears to be an empirical one."[4]

Now great size is not correlated with superiority in Crustacea *any more* than in the rest of the Animal Kingdom, and this I particularly illustrate in my first paper on the subject; for I there discuss at length the relations of rank to mean size, and of rank to size from overgrowth or vegetative enlargement. The facts in nature are always obscure of interpretation until thoroughly and properly studied; and if the relation of size to rank is among the things not understood, it is among the things to be investigated. I have endeavered to give some criteria for deciding on this point. Towards this end I have presented the consideration that where a structure is so large for the species that the animal is sluggish in its movements, or stupid in its senses, there is evidence in this that size is a mark of degradation. But I have shown, further, that where size is a mark of low grade, the low grade is also manifested in a multitude of other characters, so that we are not left to this one distinction alone. In fact, wherever size has been mentioned as one of the characteristics of an inferior group, I have rested mainly upon the others for proving the inferiority of the group.

Moreover, I have given illustrations explaining why size should be a mark of high grade, and also why in other cases a mark of low grade. I may add one or two comparisons in elucidation of this point. We all know that if a steam-engine of the size and strength for 100 horse-power has a working-force of 100 horse-power, it is an engine of respectable grade. But if, while thus large in its cylinder, beam, and other parts, it were furnished with the means of generating a force-system, as we may call it, of 1 horse-power, it would be a very feeble and worthless piece of machinery. Suppose, for closer parallelism with animal life, the engine to reach its size by a method of growth; and that

[4] From a recent letter of a critic.

its force-system attained thus a 1-horse capability when the engine had attained the size of a 100 horse-power, and poor construction with that. What would it be but a small thing vastly overgrown. In an animal there are the *sensorial* and *motorial* systems of force, which have their prime center in the cephalic nervous mass; and there is also the *vegetal*, or the power of growth or vegetative enlargement, which requires, as vegetation shows, no such nervous center, although in animals it is mostly under nervous control. If then this central control is weak, vegetative increase may make a vast structure, as unwieldy for the power within as the 100 horse-power engine with a 1-horse force-system; and it should in such a case manifest the feebleness of the force-system in an analogous manner, that is, by sluggish movements, or by stupid senses, and have corresponding structural deficiencies: as is true of a huge Medusa among Radiates, a Horse-shoe (Limulus) among Crustaceans; a Sloth and its kin among Mammals, etc., etc.

8. Mr. Walsh objects to the wide separation of the Hemipters (or Heteropters) and Homopters; and in this he is sustained by many facts and good authority. As respects this, and other like points in the classification, it is necessary to distinguish between direct inferences from the principle of cephalization, and conclusions from all the various considerations bearing on classification. By that principle, we prove that Hemipters are inferior to Homopters, since they are *metasthenic* in the wings, while the latter are *prosthenic:* but it does not also follow from it that the two groups should be so widely separated, for they may still be superior and inferior subdivisions of the same group. *Cephalization distinguishes grade among groups; but it is subordinate to type of structure in fixing the limits of natural groups.* Toward this latter object it affords aid through the many new criteria it brings to light, and through the evidence it supplies as to the relative value of such criteria; yet its distinctions are to be used in connection with all others that are available. And they have been thus used by the writer in his attempts to present the true system of arrangement among species.

I have been led to place the Homopters near the Lepidopters, and the Hemipters near the Coleopters, by the following considerations:—

a. The Homopters, as most authors assert, have close structural relations to the Lepidopters. The Hemipters are much less near the Lepidopters, and approximate, as some authors have admitted, to the Orthopters and Coleopters, especially the former. The fact that the anterior wings in Hemipters, as in the Coleopters and Orthopters, are not flying wings, is an important point

of resemblance to the latter tribes, independently of any sthenic value attached to this character.

b. The distinctions of (1) *prosthenic*, (2) *less prosthenic* or *metasthenic*, and (3) *degradational* correspond with the higher grand divisions in several orders and classes of animals. This fact, in connection with the comprehensiveness of the characteristics prosthenic and metasthenic among Insects, favors the conclusion that they are here of like importance.

c. It is common for a natural group to have affiliations in two or three directions; so that, if arranged in one division, it will have its representatives, or what might be almost regarded as its branchings, in another; and many of the fundamental relations of species can be exhibited only by systems of parallelisms with cross connections. I have observed that the Hemipters, among Metasthenic Insects, and the Homopters, among the Prosthenic, afford an example of this kind, and thus have recognized their intimate relations. Viewing the subdivisions of the classification in the lineal order in which they are presented on the printed page, the tribes of Hemipters and Homopters stand far apart, as if remote in the system of Insects. But making the Metasthenics and Prosthenics parallel divisions these two tribes stand side by side. And if the two tribes overlap through some species, it is not a solitary case of this kind in the system of animal life.

I would add here, with regard to the Trichopters, that their addition to the Lepidopteroid group, or the Amplipens, is not made as a direct inference from facts under the principle of cephalization, but on other considerations, and especially their relations to the Lepidoptera in structure. If the group were restored to the Neuropters, this would not affect at all the principles I advocate.

Passing by some other statements equally exceptionable with those which have been considered, we touch on one single point more.

9. Our objector enters his "protest, in the name of science," against "the arithmetical monomania, which is perpetually seeking to fetter the limbs of Nature in mathematical formula," alluding here to the approximate uniformity in the number of subdivisions through the system of classification proposed by me.

But Nature is throughout in a strait-jacket of mathematics. Chemical combinations, crystals, light, heat, electricity, all prove that there are simple numerical relations in the very constitution, and in all the movements, of matter; and even the multitudinous leaves of the forests are in mathematical order. It is not therefore *a priori* absurd that regular numbers should preside to some extent throughout the wide system of Nature's

living species; and if found, and not a device of the systematist, they may be recognized as a legitimate part of science, notwithstanding the above protest. Reasons for the frequent recurrence of *three*, as the number for the higher subdivisions in zoological classification, have been given in my former papers, and need not be here repeated. Protests like the above, while always exhibiting a large excess of self-confidence, might sound less presumptuous were there not *many facts in nature yet to be learned.*

ART. XXII.—*Discovery of Fossil Footmarks in the Liassic (?) Formation in Kansas;* by B. F. MUDGE, late State Geologist.

IN returning recently from an examination of the salt deposits of the Republican valley, we obtained a slab of sandstone, *in situ*, containing four impressions, and, at least, two varieties of fossil foot marks, (Ornithichnites). Although the number is small and the prints not in the best state of preservation, yet the specimens are valuable as showing a new point in the distribution of such fossils.

The locality, at which the tracks were found, is on the southwesterly bank of the Republican river, about fifty miles from its mouth. The sandstone here rises from below the bed of the river in a bluff over one hundred and twenty-five feet. The stratification is not very regular; in many cases showing an unconformable deposit, such as is frequently seen where sand is deposited in shoal water by varying currents. This was very well shown in the bluff a few feet below the strata containing the tracks. The larger portion of the bluff, in fact, bears evidence that the deposits of sand were made in shoal water. The effects of water in determining the character of the deposition are, if possible, even more marked than in the Connecticut sandstone formation.

The slab containing the tracks was found near the highest point of the bluff, on a projection within one hundred yards of the river. It is much weathered, which injures the distinctness of the footmarks. In hardness and appearance the stone is much like that obtained at Portland and other quarries in the Connecticut valley, but it varies more in texture, being frequently quite soft. The harder portions have a considerable admixture of iron, sometimes as much as ten or fifteen per cent. The iron, in its oxydation and other changes, has so affected the condition of the deposit, as, in many cases, to have obliterated all impressions made either by animal, vegetable or mechanical agents.

We could find no other track, or any other fossils at this locality. Yet it is most probable that they will be found in other places, as the deposit has a long extent in a northeasterly and southwesterly direction.

The weathered state of the specimen prevents our giving an accurate description, such as is desirable for a full identification of the species. Still, there can be no doubt that they are new kinds of Ornithichnites. The slab contains four prints, two (A, B,) on the left hand by one animal, (?)—one (C) on the upper right hand by another, and the fourth print (D) indistinct, but probably by a third bird.

A partial description may be of some value, which we give as follows. Both are *three-toed* and *leptodactylous*.

Species 1. *Track number* C.—Divarication of the lateral toes, 65°; of the inner and middle toes, 35°; of the middle and outer toes, 35°; length of the inner toe, 3·75 inches; of the middle toe, 5·1; of the outer toe, 3·75; of the foot, 5·5; distance between the tips of the lateral toes, 4·1; projection of the middle toe beyond the others, 2·1.

Species 2. *Track number* A.—Divarication of the lateral toes, 65°; of the inner and middle toes, 35°; of the middle and outer toes, 35°; length of the inner toe, 2·6 inches; of the middle toe, 3·5; of the outer toe, 3·1; of the foot, 3·75; distance between the tips of the lateral toes, 3·2; between the inner and middle toes, 2·1; between the middle and outer toes, 2·2; projection of the inner toe beyond the others, 1·2 inches.

Track number B appears to be the left foot of the bird which made No. A, as the angles and length of the toes are the same; but the position of the inner toe standing so far back of the others throws some doubt upon it. Number D may be the track of still another species, or it may belong to species 1; it is so indistinct that we cannot decide on this point.

We give no name to either of the species, as we hope more perfect prints may yet be found, which will give fuller characteristics of the animals which made the tracks. There are no marks of the claws on either of the tracks. Nor could we find any imprint of rain-drops or other peculiarities common to the Connecticut deposits. The slab containing the footprints is about four inches in thickness; it is not laminated, and shows no depression of the tracks on the under side.

We have regarded these footprints as those of birds, and we feel confident, that when more tracks are found, this conclusion will be confirmed. But every one who has studied the fossil footprints of the sandstone of the Connecticut valley, or who has read the numerous articles of the late Dr. Hitchcock on the subject, knows how difficult it frequently is to identify the order or genus to which an individual footprint belongs.

As to the geological age of the strata where the tracks were found, we cannot speak with confidence, as we have found no fossils near the locality. A few miles distant we discovered impressions of exogenous leaves, which we suspected were in the same geological horizon as the footprints, but were unable at that time to verify it. Unfortunately the specimens were lost the next day, by the upsetting of our wagon in fording a swollen stream. But we are inclined to place the formation at least as high as the Lias. Future observations may fix it still higher.

The Triassic, Jurassic and Cretaceous in this part of Kansas, are all represented by their deposits. Major F. Hawn (Rocks of Kansas, p. 4), makes the former 420 feet thick, which is more than exists in the vicinity under consideration.

Quindaro, Wyandotte Co., Kansas, Dec. 21, 1865.

ART. XXIII.—*Note on the Geology of Petroleum in Canada West;* by Prof. A. WINCHELL.

HAVING just spent a week at Oil Springs and Petrolea, in the township of Enniskillen in Canada West, and having scrutinized the statements of well-borers in reference to more than one hundred wells, and examined many actual specimens brought up from various depths, I am prepared to offer a more definite statement than heretofore of the geological position of the accumulations of oil in that region.

The surface materials at Oil Springs are from 38 to 72 feet in depth below Main street; at Petrolea, 7 miles north, about 66 feet below the general level of the country; and at Wyoming, 5 miles farther north, 120 feet deep. They consist of grayish or somewhat ferruginous clays, 10 to 14 feet deep, succeeded downwards by tough, sometimes plastic, generally stratified, blue clay, with calcareous spar, pyrites, fossils of the Hamilton group and fragments of the same formation extending to the rock or within a few inches of it. At the bottom is generally found, at Oil Springs, a bed of porous materials consisting of glacial boulders, fragments of Hamilton limestones, gravel, and in some cases flowing quicksand.

The principal mass of rock beneath, to the Corniferous limestone, consists of a series of argillaceous and calcareo-argillaceous shales; shaly, argillaceous, often pyritous and eminently fossiliferous limestone; dark, or brown, highly crystalline, hard, fossiliferous limestone, and rarely a bed of sandstone. At the base is frequently found a buff-colored, granular, porous, magnesian

limestone, often described as a sandstone. In some of the wells several feet of dark bituminous shale are found occupying a variable position in the series. In some parts of the oil-producing region the above series is overlaid by from 2 to 100 feet of black, hard, bituminous and somewhat calcareous shale. In other parts this has been denuded, and in still others the Hamilton Series is found worn down to varying depths.

The Black shale has been shown by me from stratigraphical data (Mich. Geol. Rep., 1860, p. 79; this Jour., [2], xxxiii, p. 353; Ib., xxxix, p. 351) to be the western equivalent of the Genesee shale, though by some geologists referred to the Portage group, and by others to the Marcellus shale. More recently—in May, 1865,—I obtained a few fossils (embracing *Discina Lodensis*, and *Leiorhynchus multicosta*) which perfectly establish the correctness of my former determinations. I know of no rocks of the age of the Portage group in Canada West.

The series of rocks below the Black shale is unequivocally Hamilton, and identical with the series outcropping at various places in Canada West and Michigan. The buffish magnesian limestone is likewise found at the base of the Hamilton group in Little Traverse bay in Michigan. The entire thickness of the Hamilton group proper in the oil region of Canada West is about 350 feet.

Petroleum accumulates in the porous beds at the bottom of the drift; in the fossiliferous, argillaceous and broken limestones occurring at various depths; in the porous magnesian limestone at the bottom of the series, and in numerous vertical fissures and horizontal spaces occupying various positions in the group. The various deposits are of local extent, those at the same depth in the formation not communicating through considerable distances. It sometimes occurs imprisoned in sandy spaces in the overlying clays. It is often accompanied by large or small volumes of water, and is often free from it. The oil is sometimes forced out by the elastic pressure of accumulated gas, sometimes by the hydrostatic pressure of water. Flowing wells have been fed from various depths in the rock.

Whether the supply originally ascended from the underlying Corniferous limestone or not, it is certain that no supply has ever been found by boring into that formation. Most of the wells are supplied from the Hamilton rocks; and some of the surface wells are supplied from above the Black shale. It is quite erroneous to insist that the wells are bored into the Corniferous limestone, or that they are supplied from the Upper Silurian.

In conclusion, I desire to call attention to the existence of copious oil wells bored in the Lower Silurian in Kentucky, Tennessee and the Great Manitoulin island of Canada—a fact which I announced in a publication which appeared Nov. 28th. Some

of the southern Kentucky wells commence in the Cincinnati group of argillaceous limestones and penetrate the underlying black shale.

It seems to have become established from recent researches that the petroleum of the northwest not only accumulates in several different formations but also originates from materials stored up in rocks of different geological ages from the Utica slate to the Coal conglomerate, and perhaps the Coal-measures.

University of Michigan, Jan. 8, 1866.

ART. XXIV.—*On the Aqueous Lines of the Solar Spectrum;*[1] by JOSIAH P. COOKE, JR.

A CAREFUL examination of the solar spectrum continued during several months with the spectroscope described in a recent article[2] in this Journal has led me to the conclusion that a very large number of the more faint dark lines of the solar spectrum hitherto known simply as *air* lines, are due solely to the *aqueous vapor* of our air, and hence that the absorption of the luminous solar rays by the atmosphere is chiefly at least owing to the aqueous vapor which it contains.

The appearance of the Fraunhofer's line D, seen under precisely the same conditions, but with increasing quantities of aqueous vapor in the atmosphere, is shown in figures 1, 2, 3, and 4. The D line is selected because being a favorite test-object for the spectroscope its general appearance is well known to all observers. But even more marked changes than those here illustrated have been noticed in others, but chiefly in contiguous, portions of the solar spectrum.

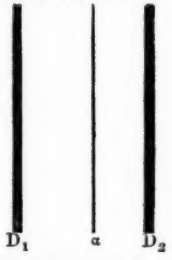
These changes attracted my attention from my earliest observations with the spectroscope; but with my first instrument, and the bisulphid of carbon prisms then employed, it was almost impossible to eliminate the effects which might be caused by the variations in the condition of the instrument itself; and, as these were known to be very great, it was possible that they might account for all the variations observed. With the improved instrument, however, just referred to, absolute constancy of action is obtained, and all merely instrumental variations avoided.

A peculiar condition of the atmosphere gave the first clue as to the cause of the changes under consideration. The weather on the 17th of November, 1865, at Cambridge, Massachusetts, was very unusual, even for that peculiar season known in New England as the Indian Summer. At noon the temperature on the

[1] Communicated to the American Academy of Arts and Sciences, Jan. 9, 1866.
[2] Vol. xl, Nov., 1865.

east side of my laboratory was 70° F., while the wet bulb thermometer indicated 66°, showing an amount of moisture in the atmosphere equal to 6·57 grains per cubic foot. At the same time the atmosphere was beautifully clear and the sun shone with its full splendor. I have never seen the aqueous lines of the spectrum more strongly defined than they were on this day, and the total number of lines visible in the yellow portion of the spectrum was at least ten times as great as are ordinarily seen.

1.
January 5, 1866.
Temperature 10° F.
Dew Point 1°·5 F.

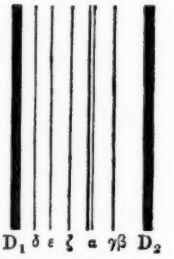


Weight of Vapor in one Cubic Foot of Air, } 0·81 grains.

2.
December 25, 1865.
Temperature 46° F
Dew Point 33°·4 F.

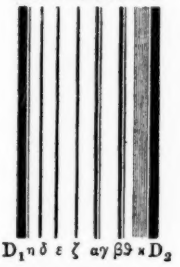
Weight of Vapor in one Cubic Foot of Air, } 2·42 grains.

3.
December 26, 1865.
Temperature 55° F.
Dew Point 46° F.



Weight of Vapor in one Cubic Foot of Air, } 3·76 grains.

4.
November 17, 1865.
Temperature 70° F.
Dew Point 64° F.



Weight of Vapor in one Cubic Foot of Air, } 6·57 grains.

The appearance of the D line on that day is shown in fig. 4. Between the two familiar broad lines D_1 and D_2 there were eight sharply defined lines of unequal intensity, which is only very imperfectly represented by the wood-cut. In addition to these on the more refrangible side of the space between the two D lines there was a faint but broad nebulous band, barely re-

solvable into lines of still lower magnitude.[1] It is impossible to represent this band accurately with a wood-cut, and the shaded broad band marked κ, on the right hand side of fig. 4, only serves to indicate its position and approximate breadth.

The 26th of December was also a warm day for the season, with a brilliant sun. At 1 P. M. the dry bulb thermometer marked 55°, the wet bulb 50°, and hence the amount of moisture in the atmosphere was 3·76 grains per cubic foot. The appearance of the D line at this time is shown in fig. 3. Two of the lines, η and ϑ, and the nebulous band κ, seen on the 17th of November were invisible, and moreover, the group of three lines $\delta\ \varepsilon\ \zeta$, on the left hand side of the figure, were only just within the limits of visibility.

On the 25th of December only two lines were visible within the D lines marked α and β in fig. 2, and the last of these was quite faint. The temperature at the time of observation was 46°; the wet bulb thermometer indicated 40°, and the amount of moisture in the air was 2·42 grains per cubic foot. The sky was clear and the sun brilliant. Lastly, on January 5, 1866, one of the clear cold days which are so common in our climate during the winter, only the single line α was visible within the D line, as is shown in fig. 1. At the time of observation near noon the dry bulb thermometer marked 10°, the wet bulb 9°, and hence the amount of moisture in the atmosphere was only 0·81 of a grain per cubic foot. The sun, however, was as brilliant as in either of the previous cases. The D line also appeared as in fig. 1, on the 8th of January, 1866, when the thermometer at noon stood at 10° below zero Farenheit, and when the barometer attained the unusual height of 31 inches.

The above figures have been drawn so as to show as nearly as possible the relative intensity of the different lines under different atmospheric conditions. As no accurate means of making the comparison are yet known, I was obliged to depend upon my eye alone, and small differences at different times of observation may easily have escaped my notice. Indeed I should have been liable to great error were it not for the fact that one of the lines within the D lines, marked α in all the figures does not vary in intensity, and served as a constant standard in making the observations. This is the only line which is given by Kirchoff in his chart of the solar spectrum between the two D lines, and it is referred by him to the nickel vapor as the D lines themselves are to the sodium vapor in the sun's atmosphere. It is an undoubted solar line and has been drawn with the same strength in all the figures in order to show that it is invariable.

[1] We use this word in the same sense in which it is used by astronomers in reference to the fixed stars.

With a very dry atmosphere the line α is the only one which appears within the D lines, as shown in fig. 1. As the amount of vapor increases the line β makes its appearance. At first it is barely visible, but as the amount of vapor increases still further it becomes more and more prominent, until at last, as shown in fig. 4, it is even more intense than the line α. A careful comparison of these two lines might indeed serve as an approximate measure of the amount of vapor in the atmosphere, and a series of comparison, made under the same conditions at different heights would give data for determining the law according to which the amount of vapor decreases with the elevation above the sea level.

All the aqueous lines change in intensity like the line β. They first appear very faintly when the amount of vapor in the air reaches a definite point, varying for the different lines, and gradually gain in intensity as the amount of vapor increases. Thus the group of three lines $\delta\,\varepsilon\,\zeta$ do not appear in fig. 2, are barely visible in fig. 3, but become very marked in fig. 4.[3] The lines η and ϑ and the nebulous band κ do not appear until the air is very moist and even when it contains 6·57 grains of vapor per cubic foot they are still very faint. Under still more unusual atmospheric conditions they will undoubtedly become more intense, and we shall then probably be able to completely resolve the nebulous band and count the lines of which it consists.

It is hardly necessary to repeat that the examples here given are selected from a large number of observations. During the cold dry weather of winter the appearance of the D line is uniformly as shown in fig. 1, the line β only occasionally appearing when the atmosphere becomes more moist. During the warm weather of summer, when the absolute amount of moisture in the air is in almost all cases greater than in winter, the appearance of the D line is as uniformly that shown in fig. 3. It is only very rarely in the dry climate of New England, even during the summer, that all the lines shown in fig. 4 are visible, and, as already stated, I never saw them before so sharply defined as on the 17th of November last. Several conditions must evidently concur in order that the aqueous lines should be developed in their greatest intensity. In the first place the air must be charged with vapor not only near the surface of the earth, but also through a great height of the atmosphere. Local causes might greatly increase the amount of moisture in the lower strata of the atmosphere and affect powerfully the hygrometer, which would not, to the same extent at least, influence the indications of the spectroscope. In the second place, other

[3] With an increasing quantity of vapor in the atmosphere the line γ of fig. 3 is seen before the group of lines $\delta\,\varepsilon\,\zeta$, and an intermediate figure between 2 and 3 might be given showing only the lines $D_1\,\alpha\,\gamma\,\beta\,D_2$.

things being equal the intensity of the aqueous lines must be strengthened by increasing the length of the path of the sun's rays through the atmosphere, and this is the longer the lower the altitude of the sun. But then again the intensity of the light has such an important influence on the definition of the lines, and the slightest haze in the atmosphere so greatly impairs the distinctness, that I have generally found that the aqueous lines are seen best when the sun is near the meridian. Hence with an equal amount of moisture in the atmosphere the late autumn may be a more favorable season for seeing the aqueous lines than the summer; for not only must the solar rays, when most brilliant at noon, traverse a greater extent of air, but moreover, the atmosphere at this time is usually clearer, and the reflected beam of light, which enters the spectroscope, is at times even more brilliant than when the sun attains a higher elevation and the light is reflected under less favorable conditions.

In the examples cited above the comparisons were made under as nearly as possible the same conditions so as to eliminate all causes of variation except the one under consideration. Days were selected when the atmosphere was perfectly clear and the sun's light, so far as I could judge, equally brilliant. Moreover, the position of the spectroscope and mirror remained unchanged during the whole time. This mirror which is used for reflecting the sun's light upon the slit of the spectroscope is so arranged that it can be turned into any position by the observer while his eye is at the eye-piece of the spectroscope, and it was always carefully adjusted to the position of best definition at each observation. The manipulation of the mirror is fully as important in the use of the spectroscope as it is in microscopy.

It will be of course understood that the power of developing these faint aqueous lines depends very greatly on the optical capabilities of the spectroscope, and that the figures here given are relative to the instrument used in the observations. This instrument has been fully described in the article already cited. It is sufficient for the present purpose to state that it is provided with nine flint glass prisms of 45° refracting angle, which bend the rays of light corresponding to the D line through an angle of 267° 37′ 50″, and that corresponding to the H_1 line through an angle of 260° 42′ 20″, when each passes through the prisms at the angle of minimum of deviation. The dispersive power, therefore, of the instrument for these two rays is equal to 13° 4′ 30″, and the rays corresponding to the two D lines are separated 1′ 10″. The object glasses of the two telescopes of this spectroscope are $2\frac{1}{4}$ inches in diameter and have a focal length of $15\frac{1}{2}$ inches, and lastly the size of the prisms and of the various parts of the instrument is adapted to these dimen-

sions. With a more powerful instrument a larger number of aqueous lines would be seen under the same atmospheric conditions. My own instrument has a set of sulphid of carbon prisms which disperse the light nearly twice as much as the flint prisms. These sulphid of carbon prisms are very variable in their action; but, under the best conditions, they might show the D line as in fig. 3, when with the flint prisms it would appear as in fig. 2.

The facts stated in this paper fully account for the discrepancies in the representations which different observers have given of the D line. Some time since Mr. Gassiot of London gave in the Chemical News a representation of the D line as seen with his instrument, showing several lines in addition to those seen by myself and other observers. On visiting the Kew Observatory, in the summer of 1864, I was surprised to find that this instrument was less powerful than the one I was then using, and I also learned that these lines were only seen on a single occasion. The moist climate of England is the evident explanation of the additional lines.

As I stated at the first of this paper the D line has been selected simply to illustrate a general truth. The development of aqueous lines in contiguous portions of the spectrum is even more marked than in the exceedingly limited portion here represented. Indeed, as has been already intimated, the number of these lines seen in the yellow region of the spectrum on the 17th of November was at least ten times as great as that of the true solar lines. That part of the yellow of the spectrum which lies on the more refrangible side of the D line, and in which during dry weather only a comparatively few lines can be distinguished, was then as thickly crowded with lines as the blue or the violet, but the lines were of course far less intense.

Professor Tyndall of London has shown by a remarkable series of experiments with the thermo-multiplier not only that aqueous vapor powerfully absorbs the obscure thermal rays; but also that the elementary gases of the atmosphere exert little or no action upon them. I have endeavored to establish in this paper, from direct observations with the spectroscope, a similar truth in regard to the luminous rays. It has been estimated by Pouillet and others that about one-third of the solar rays intercepted by the earth are absorbed in passing through the atmosphere, and it now appears that aqueous vapor is the most important if not the chief agent in producing this result. It is impossible, however, from any data we yet possess, to determine how great a power of absorption is exerted by the oxygen and nitrogen gases which constitute the great mass of our atmosphere. I have shown that a very great many, and I have no doubt that almost all the lines, hitherto distinguished as air lines,

are simply aqueous lines, but it is very difficult to distinguish atmospheric lines from the true solar lines, and our knowledge of the first is as yet very incomplete. It still remains to make careful comparisons throughout the whole extent of the spectrum before we can determine absolutely the relative absorbing power of the different constituents of our atmosphere.

One other inference from the facts here developed is worthy of notice before closing this paper. It has been for some time suspected that the blue color of the sky was in some way connected with the vapor in the atmosphere, and it is a fact of common observation that this color is more intense during the moist weather of summer than during the dryer weather of winter. The distribution of the aqueous lines through the solar spectrum not only confirms the opinion previously entertained, but also points to the cause of the color. So far as my observations have extended the aqueous lines are almost wholly, if not completely, confined to the more refrangible portions of the spectrum. Here they are found in vast numbers, and I am not positive that they exist anywhere else. If, then, the aqueous vapor absorbs most powerfully the yellow and red rays of the spectrum, the blue color of the sky is the necessary result. The color is therefore due to simple absorption and not to repeated reflections from the surface of drops of water, as some physicists have supposed.

As can readily be seen the aqueous lines of the solar spectrum present a very wide field for investigation, but one which can only be cultivated under peculiar atmospheric conditions. This paper is only intended to open the subject. I hope to be able to continue the study on every favorable opportunity, and shall take pleasure in communicating through the pages of this Journal any future results.

Cambridge, Jan. 9, 1866.

ART. XXV.—*The Distribution and Migrations of North American Birds;* by SPENCER F. BAIRD, Asst. Sec. Smithsonian Institution. (Abstract of a memoir presented to the National Academy of Sciences, Jan., 1865.)

[Continued from p. 90.]

ATTENTION has already been called to the fact that certain species, characterizing the eastern province, make their appearance in the Rocky mountains. The following is a list of those collected by Mr. Drexler at Fort Bridger (about in lat. 41°, long. 110°) in the center of the Rocky mountain range, nearly all of which have been found still farther to the northwest, toward Puget Sound. The birds found at Fort Bridger probably arrived

there by way of the Platte, those of Washington Territory by both the Platte and upper Missouri.

Although thus extending westward, almost, if not quite, to the Pacific, along the northern boundary, they appear to always return the way they went as none of the species have yet been met with in California.

I have added to each species the locality on the Missouri river up to which it was observed by Dr. Hayden in one of his early explorations.

Species of Eastern birds found at Fort Bridger.

Tyrannus Carolinensis,	Fort Union and Yellowstone.
Turdus fuscescens,	
T. Swainsoni,	
Seiurus Noveboracensis,	
Dendroica coronata,[1]	
Setophaga ruticilla,	Fort Pierre.
Vireo olivaceus,	" Union (Mr. Audubon).
Mimus Carolinensis,	" Lookout.
Zonotrichia leucophrys,	(not found farther west).
Quiscalus versicolor,	Fort Benton (Pearsall).

It will be sufficiently evident, as most birds change their residence from winter to summer, and *vice versa*, that unless we devote especial attention to their distribution during the breeding season, we shall not be able to mark their boundaries with precision. Species which go north to the Arctic circle to nest, return to mix in Mexico, Guatemala, or the West Indies, with species resident in those countries, or of short migration, and are followed part way in their southern flight by Arctic birds starting from localities still farther north. The case is quite different with reptiles, and most insects and mammals, of which a few species only change their residence or leave their place of birth, not in obedience to the instinct of reproduction, but of necessity caused by overcrowding, the search for suitable food, &c. A true parallel, however, is seen in the movements of fishes in search of a suitable place to deposit their spawn, which takes place with the same regularity as to date and direction that we find in birds.

It is only of late years that we have been enabled to determine, even with approximate precision, the winter quarters of our North American birds. Many of the species of the Eastern province are limited by the waters of the Atlantic or Gulf, crowding into Florida, Georgia, and other southern states. Comparatively few visit the West Indies; a much larger proportion reach Mexico and Guatemala, and the number of those passing farther south diminishes with the latitude. Very few of the land birds pass into South America, the following being a list of

[1] Found by Dr. Suckley on Puget Sound.

the principal species (and their southernmost mentioned limit) recorded as occurring in that portion of the continent, mostly as winter emigrants, although a few are resident.

Cathartes aura, S. America.
" atratus, "
Falco columbarius, Ecuador.
" femoralis, S. America.
" sparverius, "
Buteo Pennsylvanicus, Ecuador.
Asturina nitida, "
Nauclerus furcatus, Brazil.
Rostrhamus sociabilis, Ecuador to La Plata.
Coccygus erythrophthalmus, Bogota.
Turdus Swainsoni, Ecuador.
Mniotilta varia, Bogota.
Helminthophaga chrysoptera, Bogota.
Seiurus Noveboracensis, "
Dendroica Blackburniæ, Ecuador.
" cœrulea, Bogota.
" striata, "
" æstiva, "
Myiodioctes Canadensis, Ecuador.
Setophaga ruticilla, "
Pyranga rubra, "
" æstiva, "
Dolichonyx oryzivorus, Gallapagos.
Hirundo bicolor, Bolivia.
Vireo olivaceus, Bogota.

25 species.

The following species are recorded as occurring on the Isthmus of Panama and Darien in addition to most of those just mentioned:

Antrostomus Carolinensis,
Ceryle alcyon,
Tyrannus Carolinensis,
" Dominicensis,
Myiarchus crinitus,
Empidonax Trailli,
" flaviventris,
Dendroica coronata,
" castanea,
" Pennsylvanica,
" maculosa.
Myiodioctes mitratus,
Hirundo horreorum,
Hirundo lunifrons,
Turdus fuscescens,
Protonotaria citrea,
Geothlypis Philadelphia,
Oporornis formosus,
Helminthophaga peregrina,
Dendroica virens,
Chrysomitris Mexicanus,
Euspiza Americana,
Guiraca Ludoviciana,
Icterus spurius,
" Baltimore,
Quiscalus macrourus.

27 species.

One circumstance will attract our attention in examining these lists of North American birds reaching the Isthmus of Panama or passing beyond it as far as Bogota and into Ecuador, namely: that they embrace absolutely none of the species characterizing the middle province, all belonging to the eastern. It would seem to be the case that the migratory birds of the Rocky Mountain region go only a comparatively short distance southward into Mexico, few of them even reaching Guatemala, but preponderating on the west coast. It has already been remarked that the birds strictly characteristic of the Pacific region of the United States scarcely appear to go into Mexico at all.

While the number of land birds reaching the gates of South America, and passing through them, principally along the Andes into central New Granada and Ecuador, is so small, the case is very different with the waders, a large proportion of which are during our winter spread over the entire continent, almost as far as Patagonia. Comparatively few, however, of the Natatores follow them in this journey.

The following list comprises the principal indications of the winter visitors to the West Indies from the United States, all of them, excepting *Nephocœtes niger*, belonging to the eastern fauna.

	Bahamas.	Cuba.	Jamaica.	Other Islands.
Cathartes aura,	*	*	*?	
" atratus,		*	*	
Falco anatum,	*	*	*	
" columbarius,		*	*	Tobago.
Buteo borealis,		*	*	
" Pennsylvanicus,		*		
Rostrhamus sociabilis,		*		
Circus Hudsonius,		*		
Pandion Carolinensis,	*	*	*	Trinidad.
Nauclerus furcatus,		*	*	
Brachyotus Cassini,		*		
Otus Wilsonianus,				Tobago?
Coccygus (uncertain),				
Sphyropicus varius,	*	*	*	St. Croix.
Trochilus colubris,		*		
Nephocœtes niger,		*	*	
Antrostomus Carolinensis,		*		
Chordeiles popetue,	*	*	*	
Ceryle alcyon,	*	*	*	St. Cruz, Tobago.
Tyrannus Carolinensis,		*		
" Dominicensis,	*	*	*	St. Cruz, St. Thomas.
Myiarchus crinitus,		*	*?	
Contopus virens,		*?		
Empidonax Acadicus,		*		
Turdus mustelinus,		*		
" fuscescens,		*		
" Swainsoni,		*		
" Aliciæ,		*		
" migratorius,		*		
Sialia sialis,		*		
Mniotilta varia,	*	*	*	St. Cruz.
Parula Americana,	*	*	*	St. Thomas.
Geothlypis trichas,	*	*	*	
Oporornis formosus,		*		
Helmitherus vermivorus,		*	*	
Protonotaria citrea,		*		
Helminthophaga Bachmani,		*		
" chrysoptera,		*		
" perigrina,		*		
Seiurus aurocapillus,		*	*	St. Domingo, St. Cruz.
" Noveboracensis,		*	*	St. Cruz.
" Ludovicianus,		*	*	
Dendroica virens,		*		
" Canadensis,	*	*	*	
" coronata,	*	*	*	St. Domingo.
" Blackburniæ,	*			
" Pennsylvanica,	*			
" striata,	*	*		
" maculosa,	*	*		
" tigrina,	*	*	*	St. Cruz.
" palmarum,	*	*	*	St. Domingo.
" superciliosa,		*	*	St. Domingo.
" discolor,	*	*	*	St. Cruz.
" cœrulea,		*		
Myiodioctes mitratus,		*		
Setophaga ruticilla,	*	*	*	St. Domingo, St. Cruz.

	Bahamas.	Cuba.	Jamaica.	Other Islands.
Pyranga rubra,		*	*	
" æstiva,		*	*!	
Hirundo horreorum,		*		St. Cruz.
" bicolor,		*		
Cotyle riparia,		*	*	
Ampelis cedrorum,		*	*	
Vireo olivaceus,		*!		
" barbatula,	*	*		
" Noveboracensis,		*		
" solitarius,		*		
" flavifrons,		*		
Galeoscoptes Carolinensis,		*		
Polioptila cærulea,		*		
Certhiola Bahamensis,	*			
Passerculus savanna,		*		
Coturniculus passerinus,		*	*?	
Spizella socialis,		*		
Guiraca Ludoviciana,		*		
" cærulea,		*		
Cyanospiza cyanea,		*		
" ciris,		*		
Dolichonyx oryzivorus,	*	*	*	
Agelæus phœniceus,	*			
Xanthocephalus icterocephalus,		*!		
Icterus cucullatus,		*		
" Baltimore,		*		
" spurius,				
Columba leucocephala,	*	*	*	St. Cruz, Porto Rico.
Ectopistes migratoria,		*		
Zenaidura Carolinensis,		*		
Melopelia leucoptera,		*	*	
Chamæpelia passerina,	*	*	*	
87 species.				

From an examination of this list it will be seen that, with but few exceptions, the species that reach Panama and pass into South America occur also in Cuba as winter visitors, the principal exceptions being *Empidonax Trailli* and *flaviventris*, *Geothlypis Philadelphia*, *Dendroica castanea* and *æstiva*, *Myiodioctes Canadensis*, *Euspiza Americana*, and one or two species belonging to the middle province. It will also be remarked how many more of our species are recorded as visiting Cuba than Jamaica, 80 species instead of 36, the number becoming still less as we proceed eastward in the group. The Bahama winter fauna will probably exhibit as many continental species as Cuba, or even more when we are better acquainted with it. The comparative superiority of numbers in Cuba, is probably owing to the fact that the island, the western end especially, with the Tortugas, is a stepping stone or resting place for our species passing from Florida to Yucatan and Guatemala. This is probably the route by which most species of the Eastern province reach middle America, rather than along the coast of Texas and Mexico, many species being recorded in Guatemala and Honduras, not noted in Mexico north of Yucatan. It is the species of the Middle province that characterize more especially the winter fauna

of Central Mexico, particularly its western slope and Cape St. Lucas, and it is an interesting fact that very few of the birds peculiar to the Western province are known to occur in Mexico at all. The North American winter birds of Western Mexico, as stated, belong almost entirely to the Middle fauna, the most notable exceptions being the occurrence at Colima and Manzanillo of *Dendroica superciliosa*, *Sterna Antillarum*, and *Chroicocephala atricilla*, and at Mazatlan of *D. superciliosa*, *Mniotilta varia*, and *Seiurus aurocapillus*, none of them being found in California. The birds of Eastern Mexico are likewise in large proportion from the Eastern province of North America.

It may perhaps be proper to recall attention to the fact that, in defining the southern boundary of the Middle province and at the same time that of North America as a zoological region, I drew the line from the mouth of the Rio Grande of Texas to that of the Yaqui River at Guaymas on the Gulf of California. The space embraced between this line and the continental portion of South America, including Mexico, Central America, the Isthmus of Panama and of Darien, and the entire West Indies, I term Middle America; all south of this, South America. Trinidad alone, of the West Indies, belongs rather to South America, most of its species being common to the adjacent main land, though some are, perhaps, peculiar to it. Tobago, farther north, though with some South American species, has yet a considerable number peculiar to itself.

In concluding this part of my remarks I may state that the present lists and generalizations in regard to the distribution of our birds are to be considered merely as provisional, and that investigations at present in progress by myself and others will, it is hoped, impart much greater precision to the knowledge of the subject. In many instances I have omitted species which might have been considered as entitled to a place in one or the other tables, but this has been in most cases the result of recent determinations and different identifications than those of other authors.

Having thus briefly indicated the boundaries of the principal provinces of the North American ornithological fauna, I propose to call attention to some generalizations that have suggested themselves in reference to certain influences exerted upon species by their distribution according to latitude, longitude, and elevation, and by their association with each other. The most important of these, is the law that North American birds of wide distribution in latitude, whether migrant, or residents, will be found to be larger the higher the latitude of their place of birth.

It is well known to zoölogists that of all animals, birds are the most constant in their dimensions, so much so indeed, that size

is generally considered as a most important specific character. The comparison of many specimens of the same species from widely remote localities has shown me, however, that there is a certain variation in size, dependent on the extension northward and southward of the limits of distribution during the breeding season, the more northern being the larger, the more southern the smaller. Nor does this depend upon a greater development of body by more constant use of the muscular system in flight, as suggested by Gloger, who observed the same fact in Europe (but confined it especially to the increase in length of wings and tail), or upon a greater variety or amount of food, since the difference is as strongly marked in species constantly resident, as in those which migrate over great distances, and the development extends to the bill, feet, and all parts of the body. And in fact birds most remarkable for their great range show the least variation in size, while the variation is most evident in certain species of woodpeckers as *Picus villosus* and *Hylotomus pileatus*, which have a very wide distribution in latitude, without any special migration at all. In these woodpeckers the difference between specimens from Florida and from Canada is so great as to have given rise to the impression of there being several species of each, differing in size.

In nearly every instance where I have compared summer specimens from localities widely remote in latitude, I have found the difference referred to. A similar law prevails in regard to mammals as shown very clearly in the American deer, *Cervus Virginianus* and in the gray Squirrel, *Sciurus Carolinensis*, which are much larger in the north than in the south and larger in the mountains than in the lowlands. In mammals, if not in birds, a second law comes into play: that in the same latitudes in North America the specimens from the greater altitudes are the larger, this law appearing to extend even to man, as shown by the greater size of the inhabitants of the Appalachian region, than in those of the lowlands.

If we assume the parallel of 40° as an average line, while the specimens born farther north are larger, those born in the most southern localities are even disproportionately smaller. This is very evident in species from Cape St. Lucas, the extreme southern limit of the Middle province, where, almost without exception, the indigenous birds are so much smaller than specimens of the same species inhabiting the United States, as readily to convey the impression of being distinct new species. The same is the case, although to a less degree, in Florida, where there appears to be a tendency (found to some extent also at Cape St. Lucas) to absolute increase of the size of the bill, even with

diminution in general bulk, seen especially in *Corvus Americanus*, and *Ortyx Virginianus*.[2]

While some Florida birds are thus characterized by larger bills than their more northern brethren, several of the birds of the Middle and Western provinces have an increase in the length of the tail as compared with the same or allied species in the east. Thus *Icteria longicauda* of the Western and Middle provinces is only to be distinguished from *I. viridis* of the Eastern by the longer tail, while *Mimus polyglottus*, and *Harporynchus rufus* have each a long tailed Western variety.

Both these generalizations in regard to varieties of size and proportion, have been used with advantage in testing the claim of supposed species to this rank, and have aided in materially diminishing the accepted number of species of both mammals and birds.

Another fact which may be mentioned in reference to birds of the different provinces, is that specimens from the Pacific coast are apt to be darker in color than those from the interior, the latter frequently exhibiting a bleached or weather-beaten appearance, possibly the result of greater exposure to the elements and less protection by dense forests.

In a careful study of large series of birds of any two representative species collected near the line of junction of their respective provinces, a combination of characters of both species will often be met with, explicable only on the supposition of the hybridization of the two. Whether such hybrids are themselves fertile, or whether the cross is kept up by the constantly recurring union of individuals of pure breed of either species, I am not prepared to say, but the general facts appear to be as stated. A notable instance of this is seen in the two northern species of *Colaptes*, one, *Mexicanus*, characterizing the Western and Middle provinces, the other, *auratus*, the Eastern. The lines of distribution of the two intersect on the upper Missouri near the mouth of the Yellowstone River, and all along that portion of its course we find *Colaptes* of every possible grade of transition, or combination of the several characters of the two species; scarcely any two exactly alike, and the same individual not even agreeing in the markings of opposite sides.[3] A similar combination of characters of *Cyanura Stelleri* and *macrolopha* is met with on the headwaters of the Columbia, and on the Yukon, of *Junco hyemalis* and *Oregonus*, and of *Helminthophaga celata* and *peregrina*. Other instances can be adduced, but these will be sufficient to illustrate the facts.

[2] This disproportionate difference of size at Cape St. Lucas and south Florida is probably connected with the limited range of the species in those regions which have thus an insular rather than continental relationship.

[3] See Baird. Birds of North America, 1858, 122.

The possibility of hybridity as referred to, is another element to be taken into consideration in discussing the claim of a supposed new species to that rank.

Having thus discussed the laws of distribution and migration of the birds of North America on the continent itself, and the influence of region upon the development of the individual, I proceed to consider the subject of their movement eastward toward Greenland and Europe; that of European birds toward North America, and the several causes that appear to influence such migrations; and to present various tables of geographical distribution bearing upon the question introduced.

[To be concluded.]

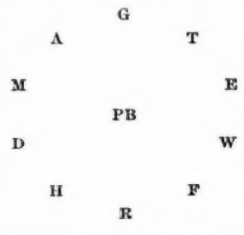
ART. XXVI.—*The relative numbers of Shooting Stars seen in a given period by different numbers of observers;* by H. A. NEWTON.

IT is often desirable to compare the hourly number of shooting stars seen by one or more observers at one time and place, with the hourly number seen by observers at some other time and place. Allowance in such cases must be made for the state of the sky, for the moonlight or twilight, for the hour of the night, and still more for the number of persons counting. In order to obtain constants for eliminating as nearly as possible this last element, I arranged, and with the assistance of others carried out, a series of observations on two nights, the 15th and 16th of August, and the 14th and 15th of November, 1865.

Evidently two persons will not see quite twice as many as one, since some meteors will in general be seen by both. Still less will three or four persons see three or four times as many as one person. Experience has moreover shown that a small number of persons cannot see all that are visible, since each one usually catches some not noticed by the others. There must, however, be some finite limit toward which, as the number of observers increases indefinitely, the hourly number seen approaches asymptotically. For we cannot regard as infinite the whole number visible at one place in a finite time.

On the night of Nov. 14th and 15th, we began our watch at midnight, and continued it until three o'clock, twelve observers counting in that time 186 shooting stars. We were stationed upon the top of one of the towers of Graduates' Hall, from which there is an unobstructed view of the heavens. Most of my assistants were students in the college. They were directed to keep their eyes constantly upon the heavens. I made the record, and did not attempt to observe. Whenever a meteor was seen each person perceiving it called out his own name, and I entered it (or rather an initial letter of it) on the record.

The heavens were divided as follows among the several observers: Mr. C. G. Rockwood (R) looked toward the south, Mr. N. P. Hulst (H) to the west of south, and so on, following around the horizon, Messrs. J. J. DuBois (D), M. D. Mann (M), A. H. Adams (A), G. H. Perkins (G), J. H. Tallman (T), E. W. Miller (E), A. Warren (W), and F. W. Russell (F). Mr. L. T. Brown (B) and Mr. W. A. Peck (P) looked to the zenith. The letters in parentheses were used to denote the several observers. Their arrangement is represented in the diagram.



The following is a summary of the observations. We denote by A the number of shooting stars seen during the three hours by Adams that were not seen by any other person; by AE the number seen by both Adams and Miller, but not seen by any one else; and so on.

A=8	BR=1	AMT=1	AETW=1	AGMTW=1
E=7	DH=1	BDR=1	AMPT=1	BEFPR=2
D=5	DM=3	BFH=1	BDMR=1	BEGTW=1
E=5	EM=1	BFP=1	BFHP=1	BFHPR=3
F=0	ET=1	BFR=2	DHMR=1	BFPRW=1
G=11	EW=1	BFW=1	EFPR=1	DHMPR=1
H=10	FR=3	BEP=1	EFPT=1	EFGPW=1
M=7	GT=2	BHR=2	EFRW=1	EFHPR=1
P=4	HM=1	DFH=1	EFTW=1	EFPRW=1
R=6	HR=5	DHM=3	EGTW=1	FHMPR=1
T=9	PR=2	DHR=3	FHPR=2	ABFHMP=1
W=2	PW=1	EGW=1	FMPT=1	AEFPTW=1
AE=3	ADM=1	EPW=1	GMTW=3	AEGMTW=2
AG=1	ADR=1	ETW=1	ABDGM=1	EFHMPR=1
AM=2	AEG=2	FHR=2	ABEPW=1	ABEFPRW=1
AR=2	AGM=1	ABGT=1	ADEMP=1	AEFHPRW=1
AW=1	AGT=1	ADHM=1	AEFPW=1	BDFHMPR=2
BF=2	AGW=1	AEGP=1	AEGMT=1	
BP=1	AMR=1	AEGW=1	AEGTW=1	

If we denote by A the whole number seen by Adams, and so of the others, we find from this table the following equations:

A=45,	B=36,	D=27,	E=42,	F=39,	G=36,
H=45,	M=41,	P=40,	R=52,	T=32,	W=31.

The mean is 38·75, which is the average number seen by each observer. Hence we have the proportion,

No. seen by one person : No. seen by twelve : : 38·75 : 186.

The numbers seen by individual observers vary between 27 and 52. The difference in the state of the sky in different directions as to haziness and clouds, and the difference in powers of vision of the observers, and in fixedness of attention, may account for this variation. In the mean of the results these

peculiarities of observers and of direction, are evidently to a great extent eliminated.

When two persons count the number of shooting stars which they can see, they naturally look in opposite directions. We shall therefore take account only of such couples, of which there are five. Designating by the symbol HT the number of shooting stars which were seen by one or both of the two observers Hulst and Tallman, and so of like symbols, we have the equations,

HT = 77, DE = 68, MW = 66, AF = 79, GR = 87.

The several observers, except the two looking to the zenith, enter symmetrically into these equations. One of these two saw 36, and the other 40 meteors, while the average number seen by each of the twelve is 38·75. Hence, only a small error will result from their omission from the equations. In the mean of the numbers above given we should have, therefore, the number seen by two observers looking to opposite quarters of the heavens, freed very nearly from personal peculiarities. This mean is 75·4. Hence,

No. seen by two persons : No. seen by twelve persons :: 75·4 : 186.

The following equations contain the same ten observers arranged in groups of threes, each observer included in three equations, and each group of three persons arranged very nearly symmetrically around the horizon. The zenith observers as before are omitted.

EMR = 113, GHW = 97, DGW = 79, DFG = 96, AHW = 105,
AEH = 109, AER = 108, DFT = 91, FMT = 93, MRT = 106.

The mean of these is 99·7. Hence,

No. seen by three persons : No. seen by twelve persons :: 99·7 : 186.

Again, selecting groups of four observers that shall be arranged as nearly as possible symmetrically around the horizon, we have,

DEGR = 123, GMRW = 124, HMTW = 113,
AFHT = 124, ADEF = 112, Mean = 119·2.

Hence,

No. seen by four persons : No. seen by twelve :: 119·2 : 186.

In selecting groups of five or more observers we may include those looking to the zenith:

ABDEF = 123, AFHPT = 134, BHMTW = 131, GMPRW = 133,
DEGPR = 134, ADRTW = 133, EFGHM = 135, Mean = 131·86,

the number seen by five persons.

Again,

ADPRTW = 141, and BEFGHM = 145. The mean = 143,

the number seen by six persons.

For seven observers we find the numbers for the seven groups formed by leaving out of the whole twelve successively the groups of fives given above. The mean of the seven numbers is 152·86.

For eight observers we form three groups by omitting successively from the twelve, DGPW, BEMR, and AFHT. The mean of the three numbers is 160·67.

For groups of nines we omit successively BDE, GPR, FMT, and AHW. The mean result is 166·75.

For groups of tens we omit in succession HT, DE, MW, AF, BR, and PG. The mean result is 173·5.

For eleven observers we omit each one of the twelve in succession. The mean result is 179·83.

These means are given in column A of the following table. Column B shows how many would be seen by a number of observers in a period during which four of them would see 1000 meteors. It is obtained by dividing the numbers in column A by the decimal ·1192:

	A.	B.	C.
Seen by one observer,	38·75	325	359
" two observers,	75·40	633	651
" three "	99·70	836	856
" four "	119·20	1000	1000
" five "	131·86	1106	1136
" six "	143·00	1200	1249
" seven "	152·86	1282	
" eight "	160·67	1348	
" nine "	166·75	1399	
" ten "	173·50	1451	
" eleven "	179·83	1509	
" twelve "	186·00	1560	

In column C are given the results of a discussion similar to that just detailed, of observations made on the night of Aug. 15th–16th, 1865. Six persons, in three hours ending at two o'clock, saw on that night 172 shooting stars. Five of them were looking in different azimuths, and one to the zenith.

It should not be forgotten that these numbers are in each instance obtained from observations continued for only three hours, a period too short to furnish a result free from accidental irregularities.

These numbers depend evidently to some extent also upon the intrinsic brilliancy of the shooting stars on the night of observation; upon their uniformity, or want of uniformity, of brilliancy; upon the clearness, or haziness, or cloudiness of the sky; upon the power and quickness of vision of the observers; and upon the degree of fixedness of their attention during the watch. The essential agreement of the two series in columns B and C, however, justifies confidence in them as a first approximation.

Toward what limit the series of numbers in column B would approach as the number of observers increases indefinitely we cannot say. The uniformity of increase in the last part of the series is due, in part, to the fact that in dividing up the heavens among the observers, to each was left a comparatively unoccupied field. It seems probable, however, that the number would attain to, and even exceed, 2000, and hence that four persons do not see more than about half of the visible meteors. The table also shows that four persons see about three times as many as a single observer.

Observers may easily furnish materials for correcting the results in this table. The nth number of column B, should be to the first number of the column, as the total number of shooting stars seen in a given period by n observers, to the average number seen by each observer. The last two terms of this proportion being furnished by observation, the ratio of the first two is computed. The following method is suggested when two or more persons undertake to count the meteors visible. Let the observers look in different directions, so as to divide the heavens, as nearly as may be, symmetrically among them. Let the whole number of shooting stars seen be counted aloud to prevent duplication. At the same time, let each observer note how many are seen by himself. To prevent confusion this may be done by marking upon a card, the eyes meanwhile not being turned from the heavens.

ART. XXVII.—*On Molecular Physics;* by Prof. W. A. NORTON.

[Concluded from p. 78.]

Magnetic Condition of the Sun.—The intimate magnetic relations subsisting between the earth and sun enforce, even in the present general exposition of terrestrial magnetism, a brief consideration of the probable magnetic condition of the sun. We have seen that the sun's surface must be traversed by magnetic currents developed in two ways: (1.) by reason of the sun's rotation about an axis; (2.) by reason of the combined effect of its motion of rotation and its motion of translation through space (p. 76). According to the most reliable determinations the sun's progressive motion is directed toward a point whose longitude is 253° 16′, and north latitude 57° 27′; and with a velocity of $4\frac{2}{3}$ miles per second, while his velocity of rotation, at the equator, is 1·3 miles per second. Accordingly the currents developed from the second cause must originate at the parts of the sun's surface that have a heliocentric longitude of about 163°; and with a gradually decreasing intensity, on both sides of that

point. The north pole of this system of currents, as developed at any moment of time, will lie in the heliocentric latitude 33°, and longitude 73°. In the course of one complete rotation of the sun (25 days), this pole will be carried around the parallel of latitude which contains that point. The resultant of the currents thus developed that will traverse any locality, at the end of one or more rotations, will therefore run parallel, or nearly so, to the equator; like the currents that originate in the simple rotation. In all this we neglect the small inclination of the sun's equator to the ecliptic (about 7°); or suppose the equator and ecliptic to coincide. It appears, therefore, that the poles of all the permanent currents should coincide with the poles of rotation.

But it is important to observe that at every moment of time there will be, coëxisting with the permanent currents, a system of new currents, originating as above mentioned; and that, therefore, there will be a *secondary magnetic equator*, crossing the ecliptic in 163° and 343° of longitude, and a *secondary magnetic pole*, in longitude 73° and north latitude 33°. Or rather the nodes and pole should be somewhat to the east of these positions; since the currents developed must decline gradually, and the rotation carry them forward. The individual parallel currents of this system must decrease in intensity, in both directions from their equator; by reason of the increasing distance from the equator of rotation of the points of tangential action of the impulses of the ether and cosmical matter, and the decreasing size of the magnetic parallels followed by the currents. It will be readily seen, in view of the fact that the sun derives its magnetism in part from its motion toward a point in the northern celestial hemisphere, that the magnetic intensity of its northern must be greater than that of its southern hemisphere.

Origin of the Sun's Spots.—The systematic observations upon the sun's spots, made by Carrington, Schwabe, Wolf, Secchi, and others, and especially the detailed discussion to which all the observations have been subjected by Prof. Wolf, have served conclusively to establish that the sun's spots have their immediate origin in some action of the planets Jupiter, Saturn, Venus, and the Earth, upon the photosphere of the sun; or in such action coöperating with some other cause. (See Astronomische Nachrichten, Nos. 839, 1043, 1091, 1137, 1150, 1160, 1173, 1181, 1185, 1223, 1234, 1270, 1289, 1294, 1355, 1526, &c.).

Prof. Wolf has determined the epochs of maxima of the sun's spots for a period comprising 100 years; and finds that the period of the spots varies from 8 to 16 years, and that its mean value is 11·15 years. He gives a formula for determining the spot-condition of the sun at different dates, in which the several terms represent the specific actions of the four planets just men-

tioned, dependent upon their masses, distances, and annual motions; which gives results in close correspondence with the results of the observations made between 1826 and 1848 (Astr. Nachr., No. 1181). He has more recently extended his investigations, so as to include, but with less certainty, a much longer period.

The epochs of maxima and minima, from 1750 to 1856, are given in the following table, to which we have added the corresponding mean heliocentric longitudes of Jupiter and Saturn; the two planets upon which the varying number of spots developed during a year, chiefly depend.

Epochs of Max.	Jupiter.	Saturn.	Epochs of Min.	Jupiter.	Saturn.
	°	°		°	°
1750·0	4·42	231·6	1755·7	177·4	301·4
1761·5	353·4	12·2	1766·5	145·1	73·5
1770·0	251·4	116·2	1775·8	67·4	187·3
1779·5	179·7	232·4	1784·8	340·5	297·3
1788·5	92·8	342·4	1798·5	36·3	104·9
1804·0	203·3	172·0	1810·5	40·5	251·5
1816·8	231·8	328·5	1823·2	66·0	46·8
1829·5	257·2	123·9	1833·8	27·7	176·4
1837·2	130·9	218·0	1844·0	337·3	301·2
1848·6	116·9	357·5	1856·2	347·6	90·4

It will be seen that, (omitting the results answering to the first two epochs of the table, which will be separately considered,) at the epochs of maxima Jupiter was in some position intermediate between the point toward which the progressive motion of the sun is directed (long. 253°), and the diametrically opposite point (long. 73°, which is the longitude of the secondary magnetic pole); reckoning from east to west, from the first point to the second. The average position is 183°; or *in the vicinity of the descending node of the currents of the secondary magnetic equator* (p. 197). Again, omitting the epochs 1755·7 and 1766·5, at all the epochs of minima the positions of Jupiter fell in the other half of the ecliptic; and his average position was in long. 23°. This is in the vicinity of the *ascending node* of the same equator, which lies somewhat to the east of 343° (p. 197). If we consider now the case of Saturn, we find that his average position at the epochs of minima was 182°; or 183°, if we take the first two epochs into account. If we separate the positions that fall in the two halves of the ecliptic, lying on opposite sides of the line from 253° to 73°, we obtain the average positions 162°, and 333°. If we include the first two epochs the latter average becomes 348°. The average position of Saturn at the epochs of maxima, was 236°.

If we now direct our attention to the first two epochs of maxima, we shall perceive that Jupiter was in that part of the ecliptic in which his ordinary action is the least; and if we refer to the first two epochs of minima, it will be seen that he was in, or

near, the part of the ecliptic in which his ordinary action is the greatest. We must conclude then that from 1750 to 1766 the normal condition of things at the two nodes was greatly changed; and that the action of Saturn conspired with that of Jupiter, to produce the anomalous results.

In view of the general results that have now been obtained, we may infer, (1.) that in general the action of a planet to produce spots is greatest in the portion of the ecliptic which contains the descending node of the secondary magnetic equator, and least in the opposite portion; (2.) that the action is approximately the same at corresponding points, on one side and the other of either node. But the indications are that a somewhat greater liability to epochs of maxima exists when the planet is on the side of the line of the magnetic nodes toward which the progressive motion of the sun is directed, than on the opposite side. This is most observable in the case of Saturn, for his average position at the epochs of maxima was 236°, while that of Jupiter was 183°.

By an examination in detail of the diverse positions of the operating planets at all the different epochs, and following their motions from one epoch to another, it may further be shown, (1.) that a planet operates more effectively before and after it has passed either magnetic node, than at the very node; (2.) that the normal positions of the two nodes are not far from 0° and 180° of longitude,—the sun's rotation having the effect to displace them about 17° toward the east (p. 197); (3.) that the principal maxima of planetary action occur at about the positions 135°, and 230°, on opposite sides of the descending node, and that under certain circumstances other positions of inferior maxima manifest themselves, lying in the vicinity and on opposite sides of the ascending node; (4.) that the principal minimum falls at about 0°, or at the ascending node, and a secondary minimum at 180° (or the descending node),—but in the normal state of things the effect of the planet appears to experience small changes in the space from 320° to 70°. These positions of maxima and minima are given, here, only as first approximations.

These results of observation, deducible for the most part from the table we have given (p. 198), and confirmed by a detailed examination of Prof. Wolf's entire series of determinations, are all decided intimations of a dependence of the sun's spots upon the varying magnetic, or electric, condition of the sun; and indicate that they are closely connected with the varying intensity of the magnetizing, or demagnetizing, action of the system of secondary magnetic currents developed by the sun's progressive motion,—in conjunction with the coöperative action of the electric waves that proceed from the region (long. 253°, and lat. 57°) upon which the impulses of the ether and cosmical matter fall

normally. Of these two operative causes, the first should augment on both sides of the secondary magnetic equator, and for considerable distances. It should be much greater on the side of the descending, than on that of the ascending node of this equator, because the new magnetic currents originate on the former side. The electric currents developed at any instant upon the ascending node side of the sun, run in the opposite direction, and tend to weaken the prevailing currents. The residual excess of the latter over the former, at any point, and at any instant, constitutes the new effective magnetic current at that point and moment of time (p. 62). Each of these two sets of currents may also play a certain part in conjunction with the magnetic currents that result from them. It will be seen, then, that the results of observation which we have signalized (pp. 198, 199,) are, in general, such as should ensue if the operative causes here considered coöperate with some action of the planets to develop the spots; each tending to enhance the effect of the other.

The tendency of the second operative cause, if it conspires in this manner with the planetary action, should be to make that action apparently the greatest when the planet is about in long. 253°; and therefore the region of the spots developed by the planet (which lies near the ecliptic on the side of the sun turned toward the planet) is nearest the central point of origination of the waves in question. On the other hand, the tendency of the same general cause should be to make the effect of the planet least at the diametrically opposite point (long. 73°).

It may be seen that if the three causes here supposed to be continually in operation,—and to be coöperating more or less according to the positions of the planets with respect to the special points of maxima and minima, alluded to, at the same time that the individual planets are conspiring more or less with each other according to their relative positions,—should determine spots by their conjoint action, their effects, in respect to the connection of the epochs of maxima and minima with certain positions of the planets, and the lengths of the periods comprised between these epochs, should correspond, in the main, with the results of observation.

From the point of view we have now reached we may gain an insight into the probable nature of the process of origination of the sun's spots. Conceiving the luminous matter of the sun's photosphere to be endued with the properties we have recognized in those emanations of solar matter that enter the earth's photosphere (p. 71–76), we may regard it as inductively magnetized by the sun's magnetic currents, and disposed in the lines of magnetic polarization; and probably also distributed into separate masses, having in the various latitudes all the diverse directions of the

sun's directive force. We have reason to suppose that in the upper portions of such masses the molecules, on each line of polarization, will be so widely separated as to be subject to an effective force of molecular repulsion from the sun (p. 69); and that in the state of equilibrium this is neutralized by the magnetic attraction between contiguous molecules. Now such a state of equilibrium may be disturbed, and the matter expelled to an indefinite distance in three ways: (1.) by demagnetization; (2.) by electric discharges along the lines of polarization; (3.) by both of these causes operating together. A demagnetization may result, as we have seen, from the new currents developed in the upper photosphere, by the tangential action of the ether and cosmical matter; and electric discharges may ensue in consequence of the propagation of electric waves, in every direction from the region (in long. 253°, and N. lat. 57°), that receives the impulses from the ether and cosmical matter normally. The points of greatest and least demagnetization should be such as have been already indicated (p. 200). But the photospheric matter should also be subject to the molecular repulsion of the masses of the different planets, and one effect of the impulses of this force should be to develop electric waves, or currents, proceeding from the region normally exposed to them. Such waves are of the same character, and originate essentially in the same manner as the "radial currents," that we have recognized as playing a conspicuous part in terrestrial magnetic phenomena (pp. 67 and 68). They should be most energetic, as in the case of these radial currents, at a certain moderate distance from the point directly under the planet; i. e., in low latitudes. On the other hand it is to be observed that for a certain distance from this point, the repulsive force of the planet may check the expulsion of the solar matter by its direct action.

The tendency to the formation of spots should be wanting at the permanent magnetic equator (or rotation equator) because the lines of polarization are there parallel to the surface, and the induced magnetism feeble. Again, the effect of demagnetization should be greatest in low latitudes, where the total magnetic intensity is the least; and where also the new demagnetizing currents are most energetic. To this we may add that as we have reason to believe that the temperature of the *mass* of the sun decreases toward the poles (pp. 66 and 76), the molecules of the photospheric matter may be less widely separated there, or be combined in groups, so as to be subject to a less energetic force of repulsion from the sun. It is conceivable, too, that in special localities the electric waves, or currents, originated by the planets may operate to disunite molecules in the act of combining, or condensing at the surface of the photosphere (the state of things supposed by Faye); and so bring them into the condition to be

repelled and completely dispersed by the repulsive force of the sun. The process of dispersion having once begun, from any cause, may extend indefinitely downward.

There is a special mode of origination of spots, connected with the sun's motion in space, that has not yet been noticed. It is, that the cosmical matter, as it flows away from the region of normal impact toward the equator, will become demagnetized, and thus initiate the process of dispersion of certain portions of the photospheric matter. This effect will be especially produced on the opposite side of the pole from the point of normal impact, as the changes of the induced magnetism will there be the greatest. A similar effect may ensue from a flow toward the equator of the matter at the very surface of the photosphere, produced by the impulses of the cosmical matter, or ether. The phenomena are precisely similar to the auroral phenomena that light up, occasionally, the earth's photosphere (p. 76). This is undoubtedly the origin of the annual maximum of spots, after the autumnal equinox, detected by Prof. Wolf. It is the result of the effects previously noticed, augmented by that here considered. An inferior maximum manifests itself in December, which is the direct result of this cause alone. (See Astr. Nachr., Nos. 1043 and 1223). It is important to observe here that when a planet is on that side of the sun, or in the vicinity of the ascending magnetic node before alluded to, it tends to check this southerly flow of matter at the surface of the photosphere, and so prevent the development of spots from the cause in question. We may add that we have doubtless another revelation of its operation in the predominating irregular disturbances of the magnetic needle in the autumnal months (or from August to December, inclusive; see Prof. Bache's Reports). The secondary maximum of the annual inequality of spots, and magnetic disturbances, near the vernal equinox, is to be chiefly attributed to the demagnetization in the vicinity of the descending magnetic node, already considered.

The spots are more numerous in the northern than in the southern hemisphere of the sun, because the low-latitudes at which they chiefly originate lie, in the northern hemisphere, nearest the region (long. 253°, N. lat. 57°), from which the electric and material currents radiate; and because in the northern hemisphere alone is the flow of the material currents in the direction to be attended with a demagnetization. Again, the spots are confined to a narrower belt in the northern than in the southern hemisphere; because the magnetic intensity of the northern hemisphere being the greatest (p. 197) the ordinary limiting parallel of the spots,—which is the circle at which the demagnetizing action, from either of the two causes specified, together with the electric discharges along the photospheric columns,

cease to be sufficient to effect the dispersion of these columns,—must lie nearest the equator in that hemisphere.

It is to be observed that spots may arise from electric discharges along the photospheric lines of polarization, although no demagnetizing action may come into operation; and it is even possible that, indirectly, an increase of magnetic intensity may, in special cases, coöperate with such currents.

Note.—Since the foregoing was written, the line of investigation here entered upon has been followed up, and new and important general results obtained. One of the principul results is: that the *density or quantity of matter of the sun's photosphere, in the region of the spots, experiences periodical augmentations*, in consequence of certain effects produced by Jupiter and Saturn while passing by the first quadrant of heliocentric longitude, and the sun's north magnetic pole; and that these augmentations of density, in connection with the subsequent diminutions, are one of the determining causes of the great variations that occur in the length of the period of the sun's spots (viz. from eight to sixteen years). Another coöperative cause consists in the diverse positions of the planets, *especially of Venus*, with respect to positions of favorable action, at the epochs of heliocentric conjunction with the earth. The other causes have been intimated.

Chemical Action.

The general nature of the process of combination of two dissimilar molecules has already been considered (p. 250). We must now contemplate it more in detail, and take note of certain distinctions, and possible differences of result. We have seen that two dissimilar molecules have an affinity for each other when their unequal molecular forces are so related that under their mutual action the atmospheres become polarized; that is, the electric ether accumulates upon one of the two contiguous sides, and is partly expelled from the other, so that the former will be positive and the latter negative. The attraction that results from this disturbance of the electric equilibrium, constitutes, as we conceive, the proper *force of affinity*, or *chemical attraction*. It ordinarily comes into operation beyond the outer limit of the molecular attraction proper (i. e., beyond Oc., fig. 1, p. 71); and draws the particles nearer together until they come within the range of this attraction,—which then determines their complete and permanent union. The force of electrical attraction, or affinity, thus brought into play should ultimately diminish, if not pass off entirely; by reason of the electric discharge that would ensue between the particles. Heat, or the electric spark, may increase the natural force of affinity, by augmenting the natural polarization that the molecular forces may have initiated. In fact all the various circumstances upon which the union of two dissimilar molecules depends are but so many different circumstances under which the molecules become polarized by their natural mutual action more or less modified.

We have seen (p. 241) that a compound molecule, when formed, becomes invested with its own proper atmosphere; and so comes into special relations with other molecules, whether simple or compound, similar or dissimilar. The density and extent of such an atmosphere may vary widely with the degree of approximation of the elementary particles, and other particulars.

The relations of heat to chemical phenomena may be deduced from the principles already stated. The heat of combination results from the condensation of the electric ether that takes place between the uniting particles, and from the compression of their individual electric atmospheres—one or both of these effects. Both of these effects should give rise to an emission of universal ether in heat-pulses.

But, according to Favre and Silbermann, certain substances combine with an attendant absorption, instead of an evolution of heat. To understand how this may happen we must observe that according to the received ideas of the true nature of chemical processes, the molecules of all substances are composed of two or more atoms associated together, and when two substances combine, it generally happens that one, or both of the two molecules presented to each other, is decomposed, and two new compound molecules are formed by condensation. Now the decomposition that precedes the combination should occasion a loss of heat, by reason of the expansion of the electric ether condensed between the constituent molecules (or "chemical atoms"), and of the atmospheres of these molecules; and the subsequent combination, by the reverse process, should develop heat. If the loss of heat from the one cause exceeds the gain from the other, there will be an effective absorption of heat, as the result of the combination. On the other hand, when chemical combination occasions an evolution of heat it is in general because the heat absorbed, while the decomposition of individual molecules is going on, is afterwards more than restored by the heat developed in the combination that succeeds the decomposition. Thus when oxygen and hydrogen combine to form water, heat is evolved because, as we conceive, much less heat is lost in the decomposition of the binary molecule of oxygen than is produced in the union of the two separated molecules (chemical atoms) of oxygen, each with a molecule of hydrogen. In some instances, as in the formation of the hydrate of lime, the molecules would seem to combine, without any previous decomposition, and any tendency therefore to absorption of heat. In the decomposition of substances, as well as in their combination, it is found that heat may either be absorbed or evolved. This fact admits of a similar explanation to that just given. M. Schröder Van der Kolk, in a memoir on the mechanical energy of chemical action, of which an abstract is given in the January

No. of this Journal (1865), lays down the following law of decomposition: "Bodies which evolve heat in being decomposed by heat are not again formed in the subsequent cooling." According to what has just been stated all such bodies must evolve heat because of the electric condensation that attends the formation of new compound molecules, after the primitive molecules have been decomposed. Now if these new molecules be cooled, the tendency would be to increase the molecular attraction by which their constituents are held together, rather than to favor their decomposition. The instances cited, viz: protoxyd of nitrogen, peroxyd of hydrogen, chlorous and chloric acids, the chlorid, iodid, and sulphid of nitrogen, seem to sustain this explanation.

It is frequently found by experiment that if heat is absorbed in the act of decomposition, the separated components will reunite on cooling. It is probable that in such instances, there is no formation of new molecules following the first decomposition, and that the heat which may be absorbed in addition to that consumed in the act of separation, is due solely to an expansion taking place after the receding molecules have been urged beyond the limit of molecular attraction, and become subject to molecular repulsion. In that event, a subsequent cooling, by contracting the atmospheres of the molecules and so increasing their attractive force, might favor a reunion. Hydrate of lime may be cited as a case admitting of this explanation.

We have seen that heat, by expanding and augmenting the repulsive energy of molecular atmospheres, tends, virtually, to polarize a surface positively; and that in this fact we have the probable origin of thermo-electricity, (p. 61), and the explanation of the effect of heat in the development of electricity by friction (p. 250). The same polarizing action of heat should favor the oxydation of metallic surfaces. The condensing action of platinum, and certain other metals upon gases, and of surfaces generally upon aqueous vapor, with evolution of heat (see this Journal, vol. xxxviii, p. 109), may be referred to a polarization developed by the mutual action of the surface and the gas or vapor. The attraction thus resulting, we must suppose, is not in general sufficient to bring the gases within the range of the natural molecular attraction, and so into complete union with the surface.

Combination by Volume.—The assumption is now generally made that the molecules of all substances in the gaseous state occupy the same volume. This conclusion to which chemists have been conducted, implies that there are the same number of molecules in equal volumes of different substances, and therefore that the elastic tension of the individual molecules, is the same for all gases. This result corresponds with the determination of

the repulsive energy of molecules at the greater distances, as given in Table I (p. 68); if we regard the coefficient, m, as constant, whatever may be the value of r. In fact the value of m, depends upon the pressure to which the molecular atmospheres are exposed (p. 241, foot note); and this, in gases, must depend mainly upon the barometric pressure, and be constant for the same pressure. It is to be observed that the results given in Table I hold good for compound molecules, provided as they are with their own especial atmospheres (p. 241), as well as for simple molecules. If r, the radius of the atmosphere of the molecule, be increased in any ratio, the value of $k\left(=\frac{m}{r^2}\right)$ will be diminished in proportion to the square of this ratio, but if we estimate the force at a given distance, this distance, as expressed in terms of r, will be diminished in the same ratio that r is increased, and hence if the force varies inversely as the square of the distance, its value at the given distance will be the same as before. The elastic force of molecules posited at the same distance from each other should therefore be the same, whatever may be the radius, r, of the molecule, simple or compound. This result depends upon the assumption that the force of molecular repulsion varies, beyond a certain limit, inversely as the square of the distance. Table I shows that for the smaller values of the ratio, $\frac{n}{m}$ (which should be taken for liquids that furnish vapors, and substances that habitually exist in the gaseous form), we have nearly reached this limit at the distance $80r$.

To this it should be added that the calculations are made upon the supposition that the ratio $\frac{n}{m}$ remains constant for each set of computations, answering to each special value of $\frac{n}{m}$. But as a matter of fact, in the transition from the liquid to the vaporous state, as we have seen (p. 75), the molecular atmospheres expand, which should diminish the value of n, and of the ratio $\frac{n}{m}$. Accordingly, to represent truly the vaporous state, it is probable that the calculations should be made for a smaller value of $\frac{n}{m}$ than any of those given at the head of the Table. If this be true the limit above referred to may be greatly reduced. This should be the case especially with the permanent gases. The distinction between the gases and vapors lies, in all probability, in the fact of a smaller value of $\frac{n}{m}$ for the former than the latter; in consequence of which compression, or reduction of tem-

perature of the permanent gases does not increase this value to the limit 4·93 at which the liquid state becomes possible.

The received theory among chemists, of combination by volume is in entire accordance with these results derived from our theory of molecular forces, and with the conception to which we have been led, of the constitution of simple, and compound molecules (p. 239, &c.). If we suppose, with the chemists, that in general the ultimate molecule is composed of two "atoms," this is equivalent to saying, in the language of the present theory, that the ultimate molecule is a compound molecule consisting of two simple molecules united together, and provided with its own proper atmosphere.

All such binary molecules of elementary gases will occupy, as we have seen, the same space, which may be called the unit of volume. If v represent any given volume, as a cubic inch, and n the number of atoms in v, then this unit of volume will be $\frac{v}{n}$. Now if one volume of one gas be presented to one volume of another the general result is that two volumes of a compound gas are formed. This implies that each of the binary molecules is decomposed, each atom of the one combines with one of the other, and thus two new compound molecules are formed, each occupying one unit of volume. If, as in the formation of carbonic acid, one volume of one gas unites with one volume of another, and one volume of compound gas is formed, we must suppose that the two binary molecules unite, as wholes, and form one new molecule containing four atoms associated in pairs. Again, if, as in the formation of aqueous vapor, two volumes of one gas combine with one of the other, and two volumes are formed, we now have two molecules a and b combining with one, c; c must be decomposed, and one of its atoms must combine with a, and another with b. Thus each molecule of water contains two atoms of hydrogen, associated with one atom of oxygen. If, as in the production of ammonia, three volumes unite with one, and two volumes are produced, three molecules must combine with one and two new compound molecules result. This implies that the single molecule and one of the three molecules are decomposed, and that the disunited atoms combine with the other two. If the molecules of the two gases, or vapors, that combine, be ever so complex, and the same number of volumes unite as we have above supposed, with the same result as to the number of volumes produced, the processes will be essentially the same as just indicated. Each compound molecule will occupy one unit of volume, whatever number of atoms, or groups of atoms, it may contain.

The decomposition of molecules which occurs in such cases, must be attributed to the molecular polarization that precedes and

accompanies the act of combination; in conjunction with, under special circumstances, the exertion of a separating force due to heat, light, or an electric current. We have seen already, in considering the process of decomposition of a molecule of water by the chemical action of zinc (p. 251), that such action upon one of the elements of a binary compound tends to separate it from the other, if the two are in conducting communication; as they would be in every true compound molecule, by reason of the electric ether condensed between them.

Chemical action of the Actinic rays.—We understand by the actinic rays, the solar rays of high refrangibility, which are capable of producing chemical effects entirely distinct from the effects of heat. From the view we have taken of the origin of rays of heat and light (p. 217, &c.), we are led to conceive of all the solar radiations as essentially of the same nature, and differing only in the rapidity of vibration, and in the intensity of the impulses propagated in the ray; and that they owe these differences to the fact that they originate in the vibrations of the atomettes of molecular atmospheres, posited at various distances from the central atoms of the molecules (p. 217). The most refrangible actinic rays should then emanate from the atomettes that lie at the greatest distances from these atoms.

The chemical action of light, and of the actinic rays in general, appears to be a consequence of the feeble repulsive individual impulses propagated in the rays that originate in the upper portions of molecular atmospheres. Such feeble impulses cannot penetrate far into the molecular atmospheres upon which they fall, and must pass around them. They should accordingly tend to urge a portion of the electric ether that may lie in their route around to the farther side of the molecule, and so to bring it into a state of positive electrization. The nature of the action that will ensue, in consequence, upon the next molecule beyond that which receives the ray, must depend upon whether there is an electric conducting connection between the two or not. If there be such connection the tendency of the action of the free electricity set in motion will be to separate or decompose the two molecules; which, in the case supposed, will be chemically united. The action here considered is essentially the same as that which occurs in the decomposition of water by zinc (p. 251). Most cases of the chemical action of light would seem to be explicable upon this idea. Thus we may explain the action of light upon an explosive mixture of chlorine and hydrogen, by the decomposition of the elementary molecules of the two gases, and the resulting formation of two molecules of hydrochloric acid. The reduction of the chlorid of silver to a subchlorid by the action of light, might result from the same general tendency to effect a decomposition of united molecules.

Heat may, in some cases, produce the same chemical result as light, or the actinic rays generally. For example, it explodes the mixture of chlorine and hydrogen. But the effect must be ascribed to the repulsive action of the heat-pulses taken up by the molecular atmospheres, at considerable depths below their surface; whereas the separating action of the actinic rays is probably due to a movement of the electric ether effected at the surface of the atmospheres. It is questionable whether the actinic rays are capable of imparting any sensible polarization to molecules. In this respect their tendency is the reverse of that of heat, viz: to impart a negative, instead of a positive polarity. For their impulses act directly upon the ether of the molecular atmospheres, but the heat impulses, as we have seen, act indirectly, producing expansion. The distinction is the same, essentially, as that taken between the two modes of action of the external impulses exerted by electric currents (p. 65); the one, analogous to light, developing magnetic currents in groups of molecules, and the other, like heat, determining a reverse polarization of molecules, compound, or simple, by an indirect expansive action.

New Haven, Jan. 15, 1866.

ART. XXVIII.—*Analyses of Rahtite, Marcylite* and *Moronolite;* by Mr. S. W. TYLER, A.B., member of the Mining School of Freiberg, Saxony, with prefatory remarks by Prof. CHARLES U. SHEPARD.

1. *Rahtite.*—This mineral was distinguished by me as a new species in March, 1861, during a survey of the Ducktown copper mines, Tennessee, where it was found in the upper, decomposed portions of the great copper-lodes, associated with melaconite and with various mixtures, of chalcopyrite, redruthite and melaconite, and also more rarely with galena and cuprite.

In structure it is quite massive, though at first inspection it seems highly crystalline; but this deceptive appearance arises from its being traversed in all directions by slender prismatic cavities imparted to it by some unknown mineral which has wholly disappeared. The walls of these cells are polished and bright. The color of the mineral is dark lead-gray with a tinge of blue, not unlike some of the ores of antimony. Its hardness and density are given below by Mr. Tyler. Thus far, it has only been found in small quantities. The name is bestowed in honor of Capt. Raht, himself a student of the Freiberg School, and now for many years the well known manager of the principal Ducktown mines.

The following are Mr. Tyler's description and analysis of the specimen submitted to him by me for examination:

"The fragments of the mineral which afforded material for the following analysis appeared to be composed of crystals, but so interwoven and indistinct that a determination of their form was impossible.

The mineral possesses a hardness of 3·5; specific gravity, 4·128 (mean of three trials which gave respectively 4·07, 4·126 and 4·188); light reddish-brown streak; metallic luster; and is of an iron-black color.

Before the blowpipe, on charcoal, it melts, with the appearance of effervescence, and coats the charcoal with oxyd of zinc. With carbonate of soda melts to a bead; which, if moistened and brought in contact with silver, blackens the latter, showing sulphur to be present. A coating of oxyd of zinc is also formed upon the coal, and metallic particles remain in the soda, of iron and copper. With microcosmic salt, in the oxydizing flame, after being strongly ignited on charcoal, it gives a bead which is green while hot, but on cooling becomes blue; and which, if treated with tin, in the reducing flame, turns of a dull red. Heated in an open glass tube it gives off sulphurous acid and turns brown. In the closed tube it remains unchanged.

The mineral was dissolved in fuming nitric acid. The sulphur which separated was collected on a dried and weighed filter, dried at 100° C., and weighed with the filter. The sulphur which had been oxydized in the process of solution to sulphuric acid was precipitated with chlorid of barium. After the excess of the latter had been removed by adding sulphuric acid, the copper was precipitated by means of sulphuretted hydrogen, and determined as sulphid of copper (Cu^2S) by Rose's method, viz: heating with a little sulphur, to redness, in a current of hydrogen gas. The iron was then precipitated, after neutralization, with acetate of soda as basic acetate of iron, ignited and weighed as oxyd of iron. Sulphid of ammonium was added to precipitate the zinc, which was determined as sulphid (ZnS) in the same manner as the copper.

·5935 grm. of the mineral gave ·0675 S; ·9505 $BaOSO^3$, containing ·1305 S; ·1041 Cu^2S, containing ·0831 Cu; ·0552 Fe^2O^3, containing ·0366 Fe; ·4238 ZnS, containing ·2840 Zn.

Per cent as follows:

	Found.	Ratio of equivalents.			Formula.	Calculated.
S	33·36	2·085	10	1		33·36
Cu	14·00	0·441	2		$\frac{2}{10}$Cu	13·22
Fe	6·18	0·220	1	1	$\frac{1}{10}$Fe S.	5·84
Zn	47·86	1·468	7		$\frac{7}{10}$Zn	47·58
	101·40					100·00"

2. *Marcylite.*—Marcylite is described on page 405 of my Mineralogy; but from less pure specimens than those submitted to Mr. Tyler. Mine appears to have contained an intermixture of

atacamite. The following is Mr. Tyler's account of his investigations.

"The specific gravity of a small piece of the mineral which I analyzed, was 4·3. It agreed in other physical characteristics with the description given in the Mineralogy.

On charcoal, the mineral swells, effervesces and melts at last to a globule of CuO. Held in the blue flame with the platinum forceps, it tinges it a bright green color. Heated in the closed tube it gives off sulphur, sulphurous acid and water. With microcosmic salt it gives the copper reaction.

This mineral was dissolved in concentrated nitric acid. From the solution, copper was precipitated by means of sulphuretted hydrogen, and determined, by Rose's method, as Cu^2S; the iron was precipitated with ammonia, and the lime with oxalate of ammonia.

To determine the sulphur, a separate portion of the substance was treated with fuming nitric acid; the sulphur which remained undissolved was filtered off, dried and weighed as such, and that which was oxydized to sulphuric acid was precipitated from the solution with chlorid of barium and weighed as sulphate of baryta.

1·0137 grm. of the mineral gave ·8132 Cu^2S, containing ·6444 Cu; ·027 Fe^2O^3, containing ·0189 Fe; 009 CaO.

·8110 grm. gave ·6437 Cu^2S, containing ·5140 Cu; and ·0205 Fe^2O^3 = ·0143 Fe.

·8749 grm. gave ·0372 S and ·8268 $BaOSO^3$, containing ·1135 S.

Several trials to determine the loss by igniting gave from 15 to 20 per cent—nothing constant however. The amount of sulphur driven off, and the degree of oxydation which the copper assumes, appear to vary according to circumstances.

	In per cent.				
	No. 1.	No. 2.	No. 3.	Average.	The composition given below demands
Cu	63·57	63·37	....	63·47	63·40
Fe	1·86	1·77	....	1·82	1·82
CaO	0·88	....	....	0·88	0·88
Na	trace	....	....	trace	....
S	....	....	17·22	17·22	17·54
Cl	trace	....	....	trace	....
		supposed O		8·00	8·00
		supposed HO		9·00	9·00
				100·39	

The composition then would be this:

CuS	47·70	=	31·7 Cu	and	16·0 S
FeS	2·86		1·82 Fe	"	1·04 S
CuO	39·70		31·7 Cu	"	8·0 O
$CaOSO^3$	2·13		0·88 CaO	"	1·25 SO^3 or 0·5 S
HO	9·00		....		....
	101·39"				

If now we consider the iron and lime as not essential, the formula will be CuS+CuO+HO.

I have considered one of the atoms of copper here as combined with oxygen; and have taken the difference necessary to make 100 as water, (or, what amounts to the same thing, have taken the water at one equivalent). The direct determination of the latter is in this case a difficult matter, and I have not the opportunity now of making it. That the above is the true composition of the mineral I think the following considerations show.

1st. The fact that sulphur is given off when the mineral is heated in a matrass proves the presence of CuS, not of Cu^2S. This leaves an atom of Cu which can be combined only with oxygen.

2nd. The presence of CuO is indicated by the following reactions. The mineral tinges the blowpipe flame green: gives off sulphurous acid in the closed tube: ammonia dissolves part of it when pulverized, to a deep blue liquid, and as CuS is insoluble in ammonia this must be CuO.

3d. All pure sulphurets of the metals hitherto described are anhydrous; the presence of water, therefore, in combination, and to such an extent as here, is a strong argument for considering the mineral partially an oxyd.

4th. There are exactly two equivalents of Cu present, and just enough excess of S above one equivalent to combine with the Fe and CaO. If now we consider the extra atom of Cu as combined with oxygen, there remain about nine per cent (8·61), which we are justified in regarding as the correct amount of water contained in the mineral.

3. *Moronolite.*—A description of this species will be found in the appendix to my Mineralogy. From the analyses here given it would appear to be nearly identical with the Gelbeisenerz found at Kolosoruk near Berlin, and analyzed by Rammelsberg, and in alum slate at Kirchspiel Modum, Norway, as analyzed by Scheerer (both referred to below by Mr. Tyler). All these substances are closely akin to the Jarosite of Breithaupt from Jaroso, Spain.[1]

Mr. Tyler gives the following as the result of his examinations.

"The analysis was conducted in the usual way so far as the bases are concerned. To determine the amount of water, (which could not be found by simple heating, as sulphuric acid would

[1] Analyzed by J. Richter with the following result:

		Oxygen,	Atoms.
Sulphuric acid,	28·8	17·25	15·1
Peroxyd of iron,	52·5	16·84	14·5
Alumina,	1·7		
Potasa,	6·7	1·14	1·
Water,	9·2	8·18	7·2

$(\dot{K}\ddot{S} + \ddot{F}e^5\ddot{S}^4) + 7$ aq.

also be driven off,) I proceeded as follows. The hygroscopic water was first determined by heating the substance at 100° C., until the weight became constant, then by strong ignition in a platinum crucible over a gas-blast ("gas-gebläse"), all the chemically combined water and a great part of the sulphuric acid were driven off, and the loss of weight was noted after the operation. The residue was treated with hydrochloric acid, in one case, in the other it was melted with carbonate of soda, and the remaining sulphuric acid was precipitated from the solution with chlorid of barium, and determined in the usual manner. In another portion, the sulphuric acid, the whole amount was found. Knowing now the amount of water and sulphuric acid together, and of the latter alone, the water is determined by the difference. The results of the analyses are as follows:

	No. 1 and 2.	No. 3 and 4.	A previous analysis.	Average.	Without the hygr. HO and the Insol.
SO^3	29·29	29·08	....	29·19	34·17
Fe^2O^3	failed	41·19	40·32	40·05	46·89
Al^2O^3	·71			·71	·83
CaO	·94	....	....	·94	1·10
NaO, KO	2·88	3·26	2·79	3·26[2]	3·81
HO	10·83	13·30		11·26	13·18
HO hygroscp.	1 46		1·62	1·53	....
Insol.	11·35	11·05	11·10	11·17	....
				98·11	99·98

This result agrees pretty well with the two analyses of "Gelbeisenerz" (from Bohemia and Norway) by Rammelsberg and Scheerer, given in Rammelsberg's Mineralchemie. I annex them for comparison.

	By Rammelsberg.	Oxygen.	By Scheerer.	Oxygen.		Ox. ratio of above.	Rammelsberg's ratio.
SO^3	32·11	19·26	32·43	19·47		20·50	15
Fe^2O^3	46·73	14·02	49·63	14·89	$\dot{Fe}$	14·45	12
KO	7·88	1·34	....	....	$\dot{Al}$		
NaO	....	....	5·20	1·33	$\dot{K}$ $\dot{Na}$	·98	1
CaO	0·64	0·18	....	....		·31	
HO	13·56	12·05	13·11	11·64		11·71	9
	100·92		100·39				

The formula of the mineral therefore would be this, $(\dot{\frac{K}{Na}}\ \bar{S}+4\dot{Fe}\ \bar{S})$ $+9Aq.$; the only peculiarity being that while the above have each but one of the alkalies, they are both present in the Moronolite.

[2] As the amount of alkali found was in all cases too small, I have taken the largest one here, instead of the average, as most correct.

ART. XXIX.—*Note on the Mechanical Equivalent of Light;* by MOSES G. FARMER, Electrical Engineer.

IN the October number of the L., E. and D. Philosophical Magazine is copied, from Poggendorff's Annalen, an article by Prof. J. Thomsen, of Copenhagen, on the mechanical equivalent of light.

His results show that about 13·1 foot-lbs. per minute represent the mechanical equivalent of a spermaceti candle, burning at the rate of 126½ grs. per hour.

On the evening of the 4th of July, 1863, there was exhibited by Mr. E. S. Ritchie, from the cupola of the State House in Boston, an electrical light, developed by the action of 250 Bunsen cells, arranged in five rows of 50 cells.

The intensity of this light was estimated by Prof. Wm. B. Rogers, by direct measurement, as equal to that of from 10,000 to 13,000 standard candles.

If we consider the electro-motive force of a Bunsen cell as equal to the evolution of one cubic centimeter of mixed oxygen and hydrogen gases per minute in a circuit of which the total resistance is equal to that of 4400 ft. of a round wire $\frac{1}{20}$th of an inch in diameter, made from electrotype copper; and if we assume also the internal resistance of such a cell to be equal to 15 ft. of such wire, (these are about the average measurements), then the maximum available electrical energy, which these 250 cells would evolve, would be

$$\frac{1}{2}\times\frac{(n\varepsilon)^2}{2\times\frac{nr}{m}}=\frac{1}{2}\times\frac{(50\times4400)^2}{2\times\frac{50\times15}{5}}=80666666$$

Since about 614 of these units of electrical energy are the equivalent of one unit of mechanical energy, we find $\frac{80666666}{614}$ =131000, foot-lbs. as the mechanical energy equivalent to the light developed.

Dividing this by the estimated amount of light we get $\frac{131000}{10000}$ =13·1, or $\frac{131000}{13000}$=10·1 foot-lbs. per minute as the mechanical equivalent of a candle light, a remarkably close agreement with the results of Prof. Thomsen.

Salem, Mass., Dec. 15, 1865.

ART. XXX.—*On Scheeletine at the Southampton Lead Mine, Massachusetts, and Uwarowite at Wood's Chrome Mine, Texas, Pennsylvania;* by CHARLES UPHAM SHEPARD.

1. *Scheeletine.*—This mineral was handed me for determination early in November by Mr. Clark of Northampton, who has watched with much diligence the materials thrown out during the recent working of the old Southampton lead mine. He found the few unknown crystals, of which he presented me four, occupying together a cavity in a cellular quartz gangue that appeared to have once contained galena. They prove to be Scheeletine. They are more or less coated by yellow crystals of carinthite, in small, low, double eight-sided pyramids; and one of them is also partially incrusted by a red-brown, somewhat botryoidal mineral which affords the blowpipe reaction of vanadinite, though the quantity employed in the trial did not permit a complete verification of this inference.

The scheeletine crystals are nearly half an inch long by $\frac{3}{8}$ths of an inch in diameter, having the form of right square prisms, imperfectly terminated by acute four-sided pyramids, whose sides have an intermediary inclination betwixt the lateral edges and planes, and are therefore hemihedral. The lateral faces are not altogether plane, but present a dissected or unfinished appearance,—a quality also perceptible in the terminations. The color is pale wax-yellow, passing into gray. The inner portions are grayish-black with a shade of blue, and have a submetallic luster. Otherwise the luster is adamantine.

Before the blowpipe, it decrepitates slightly. It melts easily, yielding vapors of lead, and leaves a dark gray globule. With borax on charcoal, it affords globules of lead, is yellow while hot, but becomes gray and opaque on cooling. With salt of phosphorus the color is yellow while hot; but it becomes colorless on cooling, unless the mineral is in excess, when it is greenish-yellow while warm, and opaque and grayish after it is cold.

With nitric acid it is partly dissolved, leaving a yellow residue. Ammonia throws down protoxyd of lead from the solution. The yellow residue on being fused with four times its weight of carbonate of soda containing a little nitrate of potassa, and treated with hot water, gave a colorless solution, which, after being acidulated with hydrochloric acid and the addition of metallic zinc, gave in a short time a rich blue color, from the precipitation of the oxyd of wolframium.

It is quite possible that this mineral may have been noticed before at the mine and been mistaken for cerasite or matlockite, one or the other of which, under the old name of the muriate of lead, has been supposed to exist at this locality.

The discovery is the more interesting when coupled with that of tungsten (scheelite) which I lately made known through this Journal, as existing along with minute crystals of cassiterite in the neighboring town of Chesterfield. Wolframium is eminently a stanniferous metal in its geological associations. And now that we have it in all its known species, either in this region or in the not far distant one of Monroe and Trumbull, Conn., we may well be encouraged to persevere in efforts to find tin in workable quantity not far distant.

2. *Uwarowite.*—This mineral was received in April, 1861, from Capt. Harris, the manager of the Chrome mines at Texas, Pa., in a collection of minerals from that region; but has been left in my laboratory here unexamined until now. The crystals are scattered through a coarsely granular, pale green clinochlore, which is also intermingled with a brownish-gray vermiculite. They are not abundant, ten or twenty in number to the square inch of the gangue. In size the largest are scarcely $\frac{1}{10}$th of an inch in diameter. The color is equal to that of the emerald, and they are nearly transparent. The hardness and luster are those of garnet. Alone before the blowpipe, it is infusible; but it slowly dissolves in borax to a beautiful chrome-green globule. Patches of apple-green chlorochromite are also scattered through the aggregate.

Charleston, S. C., Jan. 1, 1866.

ART. XXXI. — *On Sodium Amalgamation;* in a letter from HENRY WURTZ to Professor B. SILLIMAN.

IN the opinion of yourself and others upon whose judgment I rely, the time has arrived for the promulgation of the discoveries made by me, now many years since, of certain new properties of the alkali-metals, rendering them of value in the amalgamation of ores of the precious metals.

You are aware that, pending the repeated investigations which I have conducted upon this important subject, I have made communications of my results, both oral and written, from time to time to many persons, yourself among the number; but that until the latter part of the year 1864, no final step was taken to place these discoveries before the public in a tangible form. On the 27th of December, 1864, a patent of the U. S. Government was granted to me for specified modes of applying the said discoveries; the specification having been at my request retained on file in the Patent Office for six months (as the new patent law permits); so that the expiration of the term of this patent did not commence until the 27th of June, 1865.

It appears, however, that my frequent communications had led to wide discussion of the remarkable phenomena involved, phenomena which I seldom hesitated to exhibit, even to the most casual acquaintances, taking only the precaution of silence as to the agent employed (the sodium); and the inevitable consequence has been the occupation of other minds with the subject, both here and abroad. In fact, since the issue of my patent, I am informed that several applications (necessarily fruitless) have been made at Washington by others for patents covering some or all of my uses of the alkali-metals; and an English patent has been procured in the name of the eminent chemist Wm. Crookes, dated Aug. 12, 1865 (about eight months subsequent to the filing of my specification at Washington); of the specification of which I have procured a copy, and find it to present a remarkable similarity to my own. Moreover, I frequently find allusions and statements relating to this subject, generally more or less imperfect and obscure, in the public prints throughout the world.

It has clearly, therefore, become incumbent upon me—if only as a matter of justice to the mining community and others interested — to furnish authentic information as to what has actually been done, and what it is proposed to do. I have, therefore, prepared an abstract of my specification, embodying in a condensed form such portions of its substance as appear of present importance to miners and metallurgists.

Other portions of the subject-matter of the specification will form a sufficiently voluminous, and I hope interesting, topic of a future communication; as, for instance, my new modes of preparing amalgams of the alkali-metals in large masses with any desired rapidity, safety and economy; and which you, with other chemical scientists who have witnessed its operation, deem important in a purely scientific view; as involving novel phenomena, and illustrating molecular laws obscurely seen at present.

With a few explanatory observations, which seem needed, I shall conclude. I have found it necessary, for practical purposes, to prepare three different grades of the sodium amalgams, differing from each other in their proportions of sodium about as the numbers 1, 2 and 3; and which I designate accordingly.

A few lines, also, regarding the term "magnetic amalgams," which not a few will deem fantastic, and as suggesting unauthorized analogies. I hope to show, however, at some other time, that in applying the term I have followed the dictates of reason, and even the direct path of the modern leaders in cosmical dynamics, the apostles of the doctrine of correlation of physical forces; and that the analogical element which I find is that between attractive and repulsive antagonistic force which

exerts a *chemical*, or rather an *elementary discrimination* between bodies at *insensible* distances, and the antagonistic force of magnetic attraction and repulsion, which is so eminent an example of a similar elementary discrimination, though at *sensible* distances also. No one (to offer an illustration nearly, though not quite perfect) doubts the intimate relation between radiated and convected heat, although the one propagates itself throughout the universe of space, whilst the other is susceptible only of diffusion throughout insensible distances, from molecule to molecule.

More of this, however, hereafter. The term, from its convenience alone, will doubtless come into extensive use, as a technical term, among those who are most concerned in the utilization of the magnetic amalgams.

39 Nassau St., New York, January 15, 1866.

SPECIFICATION.

My invention consists: In imparting to quicksilver * a greatly enhanced adhesion, attraction, or affinity for other metals and for its own substance; by adding to it a minute quantity of one of the highly electro-positive metals * sodium, potassium * etc.

My invention * is applicable:

1st. In all arts and operations in which amalgamation by quicksilver can be made available to separate or extract gold, silver or other precious metals from their ores.

* *

3d. In all operations in which amalgamation by quicksilver, in conjunction with reducing metals, such as iron or zinc, can be made available in recovering metals from their soluble or insoluble saline compounds; such as silver from its sulphate, chlorid or hyposulphite; lead from its sulphate or chlorid; gold from its chlorid or other solution.

* *

8th. In the mercurization of metallic surfaces in general; for instance, in the amalgamation of the surfaces of zinc in voltaic batteries; of the surfaces of copper plates, pans, etc., used in the saving of gold from its ores; * *

9th. In the more convenient transportation of quicksilver, by the reduction thereof into solid forms.

* *

I shall now proceed to the description of those special and peculiar qualities of these amalgams of the alkali-metals which I have discovered, and which have led to my new uses of them in the chemical and metallurgic arts.

A quantity of one of the magnetic amalgams, dissolved in one hundred times its weight or more of quicksilver, communi-

cates to the whole a greatly enhanced power of adhering to metals; and particularly to those which, like gold and silver, lie toward the negative end of the electro-chemical scale. This power of adhesion, in the case of these two metals, is so great, that the resistance which I have found their surfaces, when in the native state, usually oppose to amalgamation (a resistance which is much greater and more general than has been hitherto recognized, and which is due to causes as yet undiscovered, or at least uninvestigated) is instantly overcome; whether their particles be coarse, fine, or even impalpable. Even an artificial coating of oil or grease (which is such an enemy to amalgamation that the smoke of the miners' lamps is pronounced highly detrimental in gold and silver mines) forms no obstacle to immediate amalgamation by this magnetic quicksilver. The atoms of the quicksilver are, as it would seem, put into a polaric condition by a minute addition of one of those metals which range themselves toward the electro-positive end of the scale; so that its affinity for the more electro-negative metals is so greatly exalted that it seizes upon, and is absorbed by, their surfaces instantaneously; just as water is absorbed by a lump of sugar or other porous substance soluble in it.

Such quicksilver (unlike ordinary quicksilver) even adheres strongly to surfaces of iron, steel, platinum, aluminum and antimony; an adhesion which, however, as I have discovered, in the case of these five metals is not of the nature of a true amalgamation, there being no penetration whatever into the substance of the metal; so that the superficially adherent magnetic quicksilver may be readily wiped off clean, just as water may be from glass. The only metal I have as yet found, which cannot be enfilmed by the use of the magnetic amalgam, is magnesium.

I shall now specify the details of my various new and useful applications of the alkali-metals:

I. *Applications of the magnetic amalgams to working the ores of the precious metals.*

My improvement in methods of amalgamating gold and silver ores consists in adding from time to time to the quicksilver used in amalgamation, about one-hundredth part, or less, of its weight of one of the magnetic amalgams. The frequency with which the amalgam is to be added cannot be exactly specified, as it will be found to depend more or less on a multitude of circumstances; such, for instance, as the temperature, the purity of the water and the quantity of water used, the ratio borne by the surface of the quicksilver to its mass, the amount and mode of agitation of the quicksilver, the nature of the process and of the

apparatus used, the character of the ore, the strength of the amalgam, etc., etc.; so that this important point can only be determined by experience in each case. Some general directions may, however, be derived from the experiments which have been made. It has been found that very much less sodium is requisite in those cases in which much water is employed, and that water frequently renewed; for instance, in the rifles of a sluice, and in all forms of amalgamators through which a continual current of fresh water is kept running; mercurial solutions of sodium, as I have discovered, being little affected by water which is free from acid, alkaline, or saline impurities. In those cases, however, in which little water is employed, and especially when the ore and quicksilver are ground up together into a "slum" or slime, this water soon becomes alkaline, and an oxydation of the sodium sets in, necessitating its frequent renewal. In such cases, therefore, the following manipulation is recommended: The whole amount of quicksilver to be used for working up a batch of slime, say 50 pounds, is magnetized by dissolving in it one per cent of amalgam No. 2; or better, two per cent of the soft amalgam No. 1, which dissolves more readily; half of the whole, or 25 pounds, is then thrown into the mill with the ore at first, and, as the incorporation proceeds, certain fractions of the other half are gradually added, at intervals of time varying according to circumstances, until the whole has been added. If, as is usual, the quicksilver is a portion which has been separated from the slime of a previous operation, it will usually retain some sodium, and therefore will require fresh amalgam in proportionately smaller quantity.

In sluicing operations the soft amalgam No. 1 is most suitable, on account of its ready solubility in mercury; and in these cases it is practicable to *test* the quicksilver in the rifles and ascertain when the magnetic quality requires restoration, by throwing in a few grains of gold-dust. Similar tests are easily applied to slimes, and in amalgamating methods generally, a slip of tarnished sheet copper being a very suitable agent for such testings.

It may be remarked in passing, that the amalgam No. 1 is at any time easily prepared from No. 2, by melting it in an iron ladle with about its own weight of quicksilver, or from No. 3, by melting with twice its weight; considerable time, however, being requisite, in the case of No. 3, to produce the additional combination. In copper-plate amalgamation, that is, in those cases in which auriferous materials are brought into contact with amalgamated metallic surfaces, it is better to substitute altogether for quicksilver itself (both in the first coating of the metallic surfaces, and in any subsequent additions of quicksilver made) the pasty amalgam No. 1. In these modes of amalgamation

great economy in wear and tear of apparatus, as well as in first cost, is effected by using, in connection with the magnetic amalgam, plates or surfaces of *iron* instead of copper. The power of coating or enfilming iron renders the amalgams in fact peculiarly valuable in every form of arrastra, drag-mill, or other apparatus for amalgamation which has internal surfaces of iron, these surfaces becoming coated over with quicksilver, and thus immensely extending its chances of contact with those particles of gold which are so fine as to remain suspended in the water.

Other important devices arise out of this power of enfilming iron surfaces, such as the keeping of iron surfaces of stamps, and of other apparatus used in *crushing* ores continually coated with quicksilver. Quicksilver possessed of the magnetic quality may be kept dropping or trickling upon the surfaces of crushing-rollers; or in those crushers in which iron balls are used, the surfaces of these balls may be kept enfilmed. In like manner as the *adhesion* of quicksilver to other metals is exalted by the alkali-metals, so, also, as I have discovered, is its *cohesion* with itself greatly increased. It is rendered more viscid, more difficult to divide mechanically, and when thus divided runs together again instantly upon contact. Hence arise new results of incalculable value. For instance, the so-called "flouring" or granulation of the quicksilver, which in the amalgamation of ores always occasions so great losses, both of the quicksilver itself and of its amalgams with the precious metals, is reduced to a *minimum* or altogether prevented.

The recovery of floured quicksilver and amalgams from slimes and similar mixtures is also greatly facilitated and accelerated thereby. For this purpose some strongly magnetized quicksilver is thrown into the separator. Such slimes may even be operated upon with advantage by the ordinary process of *panning by hand;* a little magnetic quicksilver being thrown into each pan and stirred about at first for a few moments with the hand, which will collect together and incorporate all the scattered globules of auriferous amalgam. In fact, in all panning operations, even upon the pay-dirt of placer diggings, much labor, gold, and time may in this way be saved.

It is necessary to specify an important precaution applicable in some cases in which magnetic amalgams are used, and particularly in those cases in which the ore is ground or agitated with quicksilver in contact with metallic iron. This arises from the liability of the adhesion of some abraded particles of iron to the amalgam. The following plan is therefore recommended in these cases: The amalgam, after separation from the excess of quicksilver, and before retorting, is fused in an earthen dish or iron ladle (with addition of a little quicksilver, if necessary, to make it more fluid), and the iron, which will rise and form a

scum on the surface, is skimmed off. The excess of quicksilver may then, after cooling, be again separated from the amalgam in the usual way. Any amalgam which may adhere to the iron-scum is readily detached therefrom by boiling in water to remove the sodium. This process depends on the simple fact that the adhesion to the iron totally disappears with the extraction of the last traces of sodium from the quicksilver. In fact, it is possible to remove all the iron from the amalgam by boiling directly in water, without any previous fusion; more particularly if the water be made somewhat acid or alkaline. The presence of iron in a sample of amalgam is readily detected by the magnet, which instrument may be sometimes used to advantage also in separating intermixed iron from amalgam, after all sodium has been extracted from the latter. There are still other metals which will usually be found adherent to the amalgam when sodium has been used; such as platinum and osmiridium. These, like iron, immediately detach themselves on the removal of the sodium by boiling the diluted amalgam in water. A mixture of platinum or osmiridium, or both, with iron, may of course be freed from the latter by the magnet. It will generally be found desirable, as in other cases where quicksilver is used and ores containing arsenic or sulphur operated upon, to remove as much as practicable of the arsenic or sulphur by previous roasting or other chemical treatment.

* *

III.—*Applications to the recovery of metals from their saline compounds.*

In the common operation of reducing silver to an amalgam from its native or artificial chlorid, or from its sulphate, by the action of metallic iron or zinc in conjunction with quicksilver, immense advantage arises from the use of the magnetic amalgams, especially in the reduction of the time occupied to a fraction of that heretofore required. This applies as well to ores in which the silver occurs naturally as chlorid, bromid or iodid, as to those in which the silver has been previously converted into chlorid, or sulphate, or both, by roasting with common salt or otherwise; and to chlorid which has been precipitated from solution. * * *

When gold has been obtained in solution, either from ores or from other materials, by the action of chlorine, aqua-regia, cyanid of potassium, or any other solvent, also when silver has been obtained in solution, in hyposulphites or otherwise, the most rapid and thorough mode of saving these metals will be found to be their conversion into amalgams, by precipitation with metallic iron in contact with magnetic quicksilver, more especially when the solutions are dilute. * * *

The greater rapidity and perfection of the precipitation, in

these cases, are obviously due to the absolute contact at once established with the iron surfaces by the magnetic quicksilver, and the perfect and powerful voltaic circuits thus kept up constantly throughout the two metals and the solution.

* *

VIII.—*Applications to the Mercurializing of Metallic Surfaces in general.*

In all cases in which it is an object to save time and labor in the coating of surfaces of other metals with quicksilver, * * * the magnetic amalgams come into play; * * *

By virtue of the adhesion to iron and other non-amalgamable metals imparted by the magnetic amalgams, I am enabled to apply quicksilver, or fluid or pasty amalgams, to any metallic surface, with great rapidity and facility, *with a brush*, after the fashion of a paint; the material of such brush being fine wire of iron, steel, aluminum, or platinum. Of these the material most generally suitable is the finest steel wire, tempered to about a spring temper, or somewhat softer; and the most generally useful form for such brushes, is that of a *flat* varnish or white-wash brush.

Among the important uses of such brushes may be instanced: the amalgamation of copper (or iron) plates used in saving gold from ores; * * *. Another valuable use is the recovery of quicksilver which has been spilled or scattered in the form of globules; such a flat brush, saturated with magnetic quicksilver, instantly collecting, incorporating, and sucking up the scattered globules, even from the most irregular surface.

The same principle of adhesion of magnetic amalgams to a brush of steel wire, is applicable, in many obvious ways, to the separation of metals from ores, and of granulated or floured quicksilver from ores and slimes, etc.

* *

IX.—*Applications to the Transportation of Quicksilver.*

The ordinary mode of packing and transporting quicksilver in bulk, is very expensive and troublesome; and in its ordinary form its transfer from one vessel into another is accompanied by great liability to loss. It will therefore be found very convenient and useful to possess simple, cheap and practicable modes, such as those described above, of converting it into solid forms, susceptible of transportation in vessels of lighter and cheaper material than the ordinary wrought-iron bottles; such, for instance, as glass or earthen ware jars, wooden kegs, bags or bottles, or other envelops of caoutchouc or gutta-percha, etc., etc.

This plan also enables quicksilver to be packed, stored, transported and sold in convenient forms; such as bars, ingots, cylinders, blocks, cubes, spheres, or pellets, of definite sizes and

weights, the convenience of which for many uses, and particularly for that of miners, is at once obvious. When the quicksilver is to be used in any of the arts above specified, it will then be already in a suitable condition, or will merely require admixture with some fluid quicksilver; and when to be used as pure quicksilver, the sodium may be removed by throwing the solid amalgam in fragments into hot water, preferably mixed with a little sulphuric or acetic acid.

The modes of packing such ingots, for preservation and transportation, are already sufficiently set forth in a preceding paragraph.

Claims.—The claims attached to this specification are twenty-three in number; and those only are here given which directly concern the miner and amalgamator.

What I claim as my inventions are:—

1st. The combination with quicksilver, when used for the extraction by amalgamation of any metal or metals from ores, slimes, and mixtures with other materials; of metallic sodium, or metallic potassium, or any other highly electro-positive metal equivalent in its action thereto; as above set forth.

2d. In those amalgamators in which amalgamated plates of copper or other metal are used; the substitution therefor of plates or surfaces of iron, coated with quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

3d. The coating of iron surfaces, between or under which ores or other materials are crushed, with quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

4th. The prevention of the granulation or flouring of quicksilver, when used in any method of amalgamating ores or other materials; by addition thereto of sodium, or other highly electro-positive metal; as above set forth.

5th. The separation of intermixed iron from double amalgams of gold and sodium, or of silver and sodium; by fusion with excess of quicksilver and skimming; as above set forth.

6th. The separation of intermixed iron, platinum, osmiridium, and other non-amalgamable metals, from amalgams containing sodium or its equivalent; by action thereupon of water or other oxydating liquid; as above set forth.

7th. The separation of intermixed iron from amalgams containing sodium or its equivalent, or from any metal or metals extracted from such amalgams; by magnets, either permanent or electro-magnetic; as above set forth.

8th. The combination with quicksilver, when used in conjunction with iron or other reducing metals, for reducing to an amalgam, silver from its chlorid or other compound, or any

other metal from any saline compound or solution; of sodium, or other highly electro-positive metal; as above set forth.

* *

12th. In all cases in which metallic surfaces, such as copper plates, the zincs of voltaic batteries, etc., are to be amalgamated; the use of quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

13th. The more rapid and convenient application of quicksilver to surfaces with metallic brushes; by virtue of its previous combination with sodium, or other highly electro-positive metal; as above set forth.

14th. The use of metallic brushes, enfilmed with an amalgam of sodium or its equivalent; for incorporating together particles of quicksilver, gold, silver, or any other metal, scattered throughout ores, slimes, or any other materials; as above set forth.

15th. The more convenient transportation, handling and subdivision of quicksilver; by conversion into solid forms; in the manner herein substantially described.

* *

Editorial Note.—At the session of the National Academy of Sciences held in Washington in January last, Prof. Silliman read a paper upon the sodium amalgamation, detailing the results of a series of experiments conducted by him upon a scale of sufficient magnitude to test the value of this discovery upon gold quartz. In one experiment made on over 500 pounds of low grade ores, worth about $15 per ton, the sodium amalgam extracted practically all the gold not existing in the sulphids. This experiment was conducted in a large-sized Freiberg amalgamator and was continued through one hour, the sodium amalgam being added in four successive portions of one ounce each, dissolved in a portion of the 20 pounds of mercury employed. The loss in mercury was about one ounce in this experiment, the quantity of the sodium amalgam being 1·2 per cent of the total quantity of mercury in use.

In a second series of experiments conducted on carefully prepared samples of richer ore, worth $320 per ton, treated in a revolving barrel, the saving by ordinary mercury was from 40 to 60 per cent of the total quantity of gold present. With the aid of sodium amalgam 83·3 per cent were recovered. The results in the large way in actual practice would probably be more satisfactory than those last named. Prof. S. stated that experiments had also been set on foot in California to test this process on a large scale in the actual working of quartz mills. The results of these experiments will be noticed hereafter.

ART. XXXII.—*Caricography;* by Prof. C. DEWEY.

(Continued from vol. xxxix, p. 73, 1865.)

No. 286. *Carex Hartii*, Dew.

Spicis staminiferis 1–3, sæpe 2, interdum 1, vel raro nulla, cylindraceis gracilibus variis erectis, suprema longiore in medio vel supra vel infra fructifera, sessilibus squamas lanceolatas acutas subfuscas ferentibus; spicis pistilliferis 2–7, vulgo 4, cylindraceis oblongis sublaxifloris et infra præcipuè subremotis plerumque erectis foliaceo-bracteatis, superioribus sessilibus sæpe ad apicem staminiferis, inferioribus exserto pedunculatis interdum supra staminiferis infimis duobus longo-exserto-pedunculatis interdum recurvis, cum bracteis culmum superantibus; fructibus *tristigmaticis* ovatis inflatis vel conico-ellipticis longo-rostratis et teretibus bidentatis nervosis infra teretibus et stipitatis lævibus divergentibus et adultis prope retrorsis, squama lanceolata acuta margine albida latera fusca multum longioribus; culmi foliis longis strictis nodosis per-angustis margine scaberrimis et sæpe culmum lævem plusquam duplo præcedentibus.

Culm 15–25 inches high, erect, slender above, smooth except the highest part of the edges, with bracts and leaves surpassing the culm, and the leaves very narrow and long, often more than twice the length of the culm and very scabrous on the edges, knotted: spikes very variable; the wholly staminiferous 1–3, commonly 2, nearly half 1, very rarely 3 or none, cylindric, slender, sessile; some staminiferous have a few fruit in the middle or at the base or vertex; the terminal much the longest, and all clothed with lanceolate acute scales; pistilliferous spikes 2–7, usually 4, the highest with stamens at the summit or in the middle or both and sessile, the next higher exsert pedunculate and erect, the lowest one or two very long-exsert pedunculate sometimes recurved, and the lowest sometimes staminate at apex, all oblong-cylindric, ½ to 2½ inches long, mostly erect, rather distant, loose-flowered, especially below, bracteate and the lower with long-leafy bracts surpassing the culm and rough-edged; stigmas 3; fruit ovate-conic, inflated, long conic-rostrate, bidentate, nerved, tapering below, and stiped, diverging or nearly retrorse in maturity, much longer than the slender ovate lanceolate scale.

Wet grounds, Dundee, Yates Co., N. Y., discovered by Dr. S. Hart Wright, Ludlowville, Tompkins Co., H. B. Lord. Hastings Rood, Canada West, J. Macoun.

The *retrorse* fruit brings up *C. retrorsa*, but the difference in the spikes and culm and fruit is too great, and the achenia are very dissimilar. *C. retrorsa* has achenia long and round sub-triquetrous; the other has shorter triquetrous achenia tapering from the middle toward each end, and not roundish.

Var. *Bradleyi*, Dew.

Staminate spikes less various; pistillate spikes more loosely flowered; fruit smaller; and plant more slender.

Wet grounds, Greece, ten miles west of Rochester, Dr. S. B. Bradley. Here Dr. B. had discovered *C. mirata*, and was searching for its rediscovery, 1861. Also, at Belleville, Canada West, J. Macoun.

No. 287. *C. vaginata*, Tausch 1821.

Spicis distinctis; staminifera unica oblonga culmo stricto fulta vel "sub-anthesi rectangulè refracta;" pistilliferis sub-binis oblongis laxifloris remotis erectis linearibus exserto-pedunculatis lato-vaginatis; fructibus *tristigmaticis* triquetro-ovatis basi attenuatis brevi-rostratis bidentatis, squama oblonga sub-obtusa longioribus; culmo lævi foliato, foliis longis lato-linearibus margine supra scabris, bracteæ vagina vix foliaceum cuspidem abruptam ferente; culmo perlævi.

This plant is widely spread over Germany and Scandinavia, but it is so variable that Kunze in 1840–50 gave twelve synonyms in the nineteen authors he quotes on this species, and omitted the name given by Fries, *C. sparsiflora*. In my specimens from Europe, and one of them from the hand of Fries (in my collection), there is too great a difference for identity of species; and if so, different plants may have been confounded by some authors. The one from Fries has a pair of too close-fruited spikes, scarcely sheathed, too nearly sessile, and bracts too leaf-like. The others correspond chiefly to the above description, authorized by those of Fries, Lang, Anderson, Kunze and Steudel. In Hooker's Flora Bor.-Amer., Dr. Boott gave *C. phœostachyæ*, Smith, as synonymous with *C. vaginata*, Tausch, as does Kunze also, and credited it to Greenland, Fort Norman on Mackenzie River, and Rocky Mts. It is doubtless the European plant. Dr. Gray informed Mr. Paine, who had found a variety in this vicinity, that *C. vaginata* had been found near Montreal by the late Mr. Macrae, and later at the "Riviere du Loup by W. Boott." A recent examination of Dr. Macrae's plants by Prof. Brunel of Quebec did not detect any plant of that name. I had hoped to ascertain whether the Montreal specimens agreed with the European or with the varieties found by Mr. Paine. This differs however from the European in so many particulars that a more full account is given under the following name.

Var. *alto-caulis*, Dew.

Spica staminifera brevi cylindracea erecta vel infra "*rectangulè refracta;*" pistilliferis spicis 1–3, sæpe 1, vulgo 2, per-rarò 3, cylindraceis brevibus laxifloris vel alterno-fructiferis sub-vicinis vel remotis, suprema subsessili, infima interdum subradicali exserto-pedunculata, bracteatis vaginantibus, fructibus *tristigmaticis* ovatis ovato-conicis ellipticis interdum obovatis infra teretibus substipitatis subtriquetris lævibus nervosis brevi-rostratis bidentatis, rostro recto vel refracto, squama subacuta duplo longioribus: culmo alto-cauli infra lævi inclinato longi- et arcti-foliaceo: vagina angusta cum folio.

Culm 12–30 inches high, very slender and nearly filiform above, stiff and inclined, with culm leaves about half as long, sometimes longer; staminate spike single, short-cylindric or oblong, often distant from upper pistillate, erect or with *stem bent rectangularly above* and near that pistillate, with scales oblong and obtuse, green on the back and reddish on the sides or wholly; pistillate spikes 1–3, often 1, commonly 2, very seldom 3, cylindric, short, erect, loose-flowered or alternate-fruited, near or often quite remote; lowest rarely subradical, long-pedunculate, upper sometimes nearly sessile, lower enclosed or exsertly pedunculate, bracteate with a narrow and longer foliate sheath; stigmas three; fruit ovate or ovate-conic-elliptic, sometimes obovate-triquetrous, tapering below, stiped, short-

rostrate and the beak often turned one side or refracted, two-toothed, smooth, near twice longer or rarely little longer than the ovate or oblong obtuse or sub-acute scale.

Discovered in a marsh in Bergen, 20 miles west of Rochester, by Rev. J. A. Paine; the first known locality in the United States; fruit mature in June, 1865. On some of the Bergen specimens, the *refraction* of the *culm* below the staminate spike and of the *beak* of the fruit, especially of the early mature plants, is striking. Both of these curious particulars are found on many of the European specimens. The former is given in the description of Kunze and Steudel as a common fact, and in some popular remarks of Fries; and the latter is alluded to, with the other, as of no consequence, by Andersson in his Cyperaceæ Scandinaviæ; while Lang states of the former that he had examined it on the *C. vaginata* cultivated in a botanic garden, but had never found it on one of the numerous specimens he had collected or growing in their indigenous state. Of course Dr. Lang did not introduce the *refraction* of the stem into his description of this species.

The height of *C. vaginata* (5 to 12 inches by Steudel), the greater width of the leaves (foliis latis, Lang); the short cuspid-like leaf or termination of the broad sheath in Andersson, so clear on the specimens from Europe and on the figures of Kunze and Andersson, the more thick and coarse leaves and more stocky form, as well as differences in the fruit, distinguish the Bergen plant from the European.

No. 288. *C. Macounii*, Dew.

Spicis variis *ordinatis* distinctis vel *inordinatis* cylindraceis erectis bracteatis; ordinatorum staminiferis 2, inferiore breviore longo-bracteata, terminali longiore, squamas longas graciles lanceolatas infra sparsas ferentibus; et pistilliferis 4, suprema subsessili, cæteris remotis longo-pedunculatis: ordinatorum terminali staminifera longa et fructifera pistillis paucis supra vel medio vel infra interpositis, vel interdum terminali apicem pistillifera et dimidio inferiore fructifera, tunc terminali pistillifera longa et in medio vel basi pauco-staminifera; spicis pistilliferis subquinis cylindraceis erectis laxifloris, inferioribus longa exserto pedunculatis, infima apice vel medio rarò staminifera: fructibus *tristigmaticis* ovatis longo-conico-subinflatis lævibus nervosis brevi-furcatis substipitatis longo-gracili-rostratis divergentibus vel rectangule separatis, squamam ovato-lanceolatam ad basin aequantibus vel supra superantibus; bracteis foliisque margine vix scabris et culmo lævi longioribus; culmo foliis basin breviore.

Culm one to two feet high, erect, smooth; bracts and leaves long, narrow, linear-lanceolate, the lower much surpassing the culm, smooth but slightly scabrous on the edges, nodose; spikes six, cylindric, pedunculate; the pistillate 1–2½ inches long, sessile above and sheathed exsert-pedunculate below, very *variable;* as (1.) regular, staminate spikes 2, terminal, cylindric, long, the lower short with a long slender bract, both bearing long lanceolate scales very lax below, and the pistillate 4, uppermost subsessile and the others remote, long pedunculate, erect; (2.) irregular, staminate spike terminal long, with a few scattered fruit at the vertex or in the middle or below, and pistillate 5, with some stamens at the vertex of the upper, sometimes the terminal 2–3 inches long and upper half pistillate with the lower half staminate, sometimes the terminal

pistilliferous long with few stamens in the middle or at the base, sometimes the lowest pistillate with some stamens at its apex and in the middle; all the pistillate loose-flowered especially below; stigmas 3; fruit ovate long-conic, inflated at base, rostrate with beak slender and bidentate, diverging or nearly rectangular below, smooth, nerved, generally longer than the narrow oblong acute and awned or ovate-lanceolate scale, or at the base of the lower spikes the fruit is sometimes scarcely longer than the scale; plant straw-yellow.

At streams in Seymour, Northumberland Co., Canada West, J. Macoun, whose name the discovery honors. Though related to *C. follicutata* L., it seems quite different, and the achenia wholly unlike; future forms may show more clearly its relations.

No. 289. *C. Canadensis*, Dew.

Spicis distinctis; staminifera unica perlongo-cylindracea erecta remota et bractea foliata e basi distante, squamas longas latas lanceolatas ferente: spicis pistilliferis 1–3, vulgo 2, sæpe 1, per-rarò 3, oblongis cylindraceis erectis subdensifloris, inferiore interdum brevi-ovata et sæpe per-longo-pedunculata; fructibus *tristigmaticis* ovato-conicis inflatis conico-rostratis bifurcatis subtriquetris nervosis glabris, squama ovata brevi-acuta vel aristata plus duplo longioribus; bracteis foliisque margine supra scabris culmum lævem superantibus.

Culm 15–24 inches high, erect, rather slender, very smooth, leafy toward the base; leaves and bracts surpass the culm; spikes distinct; terminal staminate long-cylindric, remote from its bract and more from the pistillate, erect and slender, covered with long broad lanceolate scales; pistillate spikes 1–3, commonly 2, often 1, very rarely 3, cylindric, oblong, erect, the lowest sometimes short and ovate and long exsert-pedunculate, bracteate and sheathed, sub-close-fruited; stigmas 3; fruit ovate, inflated, conic-tapering into a 3-sided beak, which is rather deep bifurcate and sub-scabrous on the edges, nerved and smooth, more than twice longer than the ovate acute or awned scale; plants yellowish.

Small ponds at Seymour, Northumberland Co., Canada West, J. Macoun. I have seen nothing like it in the specimens obtained by me. It has been referred to *C. lupulina*, but the achenia much differ, as well as the spikes and fruit.

No. 290. *C. Bella-villa*, Dew.

Spicis staminiferis 2–3, ferè 3, cylindraceis erectis vulgo approximatis sub-remotis, terminali longiore et omnibus bracteatis sessilibus longo-squamiferis; pistilliferis vulgo 2, interdum 1, cylindraceis erectis exsertipedunculatis brevi- et lato-vaginatis per-laxifloris suprema apice staminifera; fructibus *tristigmaticis* longis gracilibus ovato-lanceolatis conicis basin inflatis nervosis lævibus per-divergentibus rectangule positis vel sub-retrorsis rostro longi-bifurcato subtriquetro longo-stipitatis, squamam longam lanceolatam dorso viridem infra subæquantibus supra prætantibus bracteis foliisque margine scabris culmum foliatum superantibus. Achenium est triquetrum infra teres supra brevi-rotundum triquetrum.

Culm about 1½ foot high, erect, strong, leafy toward the base, rough a little on the upper part; bract-leaves rise from short broad sheaths, and with the leaves surpass the culm; staminate spikes 2–3, commonly 3, cylindric, erect, near or sub-remote, the terminal often longer, all ses-

sile and bearing long lanceolate scales, rough to the eye but soft to the touch; pistillate spikes commonly 2 and rarely 1, cylindric, exsert-pedunculate, erect, very loose-flowered, short and broad sheathed, the highest staminate at the apex and nearly sessile, the lowest sub-remote; stigmas 3: fruit long, slender, ovate-lanceolate, conic, nerved, smooth, diverging and horizontal or sometimes retrorse, stipitate, with a back deeply bifid or bifurcate, quite equalling the scale at the base and exceeding the scale at the upper part of the spike. Plant yellowish.

Near Belleville, Canada West, J. Macoun: a fine species.

No. 291. *C. verticillata*, Boott. Illust. 1858.
— *angustata* var. *verticillata*, Boott. Fl. Bor.-Am. 1850?

Spicis cylindraceis 5–6, angustis; staminifera unica terminali squamas fuscas obtusas ferente; pistilliferis, 4–5, erectis, superioribus apice staminiferis sub-densifloris, inferioribus 1–2, infra laxifloris et basin attenuatis sejuncti-floris vel *verticillatis* pedunculatis bracteatis; fructibus *distigmaticis* ovalibus parvi-orbiculatis plani-convexis brevi-apiculatis, squama obtusa vel subacuta brevioribus; culmo gracili basin foliato infra lævi.

Culm 18 inches high, slender, smooth below and leafy: bracts not sheathing, leaf-like, the tower about as long as the culm; staminate spike single, erect, scarcely bracteate, and with obtuse tawny scales; pistillate spikes several, cylindric, 1–2 inches long, rather close-flowered above, the lower remote and verticillate-flowered, scarcely pedunculate; stigmas 2; fruit oval or oblong, small, roundish, flat-convex, shorter than the oblong-acute scale below or the oblong-obtuse scale above.

Columbia River, Scouler; Oregon, Nuttall; and Kansas, Hayden.

To Dr. Boott's description of this species corresponds *C. Haydenii* Dew., in this Journal, 1854, except the two important characters of the fruit and its scale. Though the Kansas specimens are not very definite, they seem referable on the whole to this species, which only Dr. Boott had recognized.

No. 292. *C. Rœana*, Boott. Illust. No. 63, et Rich. Exp. Arc. 1851.

Spicis distinctis cylindraceis erectis; staminifera 1–2, terminali pedunculata, interdum vel raro obtusa brevi sessili subremota, squamas oblongas brevi- vel longi-acutas ferente; spicis pistilliferis sepius 2, sessilibus remotis, inferiore subinde vaginata brevi- et exserti-pedunculata, bracteatis; fructibus *tristigmaticis* oblongi-ovatis rostratis bifurcatis parvi-inflatis nervosis, squama oblonga lanceolata acuta vel cuspidata margine albi-hyalina paulo longioribus; culmo 1½ pedali gracili triquetro lævi vel subscabro foliaceo; foliis angustis involutis culmum æquantibus.

North America, Methye Portage, Richardson, as stated by Dr. Boott. In form this species much resembles *C. oligosperma*, but Dr. B. gave to it the name of Richardson's "friend and companion Dr. Raea." It differs from *C. oligosperma*, in its longer pistillate spikes many flowered, and the lowest loose flowered, especially below, in its longer-rostrate and less inflated fruit; in its achenium. So well marked by Dr. Boott are these differences that it is likely to stand an acknowledged species. The seed or nut given by Dr. Boott differs greatly also from that of *C. oligosperma* in his Illust., No. 62. Some specimens from the base of the White Mountains, N. H., are near it at least. As the plant may be found in the northern and colder part of our country, it is desirable to extend the circulation of Dr. Boott's description.

[To be continued.]

Art. XXXIII.—*Whitney's Geology of California.*[1]

In the last number of this Journal the publication of the second volume of the Reports of the Geological Survey of California, was announced. This is the first volume of the Geology, the preceding volume being devoted to Paleontology. We have perused it with care, and with unusual interest, but find it difficult to epitomise it within the limits of an article suitable for this Journal. The volume is a "Report of Progress and Synopsis of the Field-work, from 1860 to 1864," so far as this work related to general geology, and is a record of the facts observed, condensed to the last degree.

It is evident from its perusal that the geological structure of California is by no means so simple as that of similarly large areas east of the Rocky Mountains. It may be simple in its main outlines, but it is very complicated in its details, and it is only by a study of these details that the wider generalizations are apparent. Professor Whitney foreshadowed some of the results here given, in his preface to the first volume of the Paleontological Report, and more fully in an article in this Journal, vol. xxxviii, pp. 256, 298.

It was then announced that he considered the Coast Ranges to be made up of the Cretaceous and Tertiary, and the Sierra Nevada of newer Carboniferous, Triassic, and Jurassic formations, the auriferous rocks on the western slope and argentiferous deposits of the east, being mostly in the Triassic and Jurassic, judging from the fossils obtained and the number of localities in which they occur.

In the volume before us he gives as many of the data from which these and other conclusions have been derived. We proceed to notice some of the more interesting facts.

The subject is naturally divided into two parts, one relating to the Coast Ranges, the other to the Sierra Nevada; but in the arrangement of the subordinate parts, no systematic order has been pursued except such as is most convenient. The main

[1] Geological Survey of California, by J. D. Whitney, State Geologist. Geology Volume I. Report of Progress and Synopsis of the Field-work, from 1860 to 1864. 498 pp. roy. 8vo, with numerous illustrations. Published by authority of the Legislature of California. 1865.

In the field-work of the survey Prof. Whitney was assisted during the whole period by Prof. W. H. Brewer, who had charge of the Botanical Department, but who labored also in geological exploration; during 1860 to Feb. 1861, by Mr. William Ashburner, as assistant in the Geological field-work; from 1861 to 1864, by Mr. C. F. Hoffmann as topographical assistant; 1862–1864, by Mr. W. M. Gabb, as paleontologist; 1863–1864, by Mr. Clarence King, as volunteer geological assistant; in 1864, by Mr. Gardiner, also volunteer assistant. The force is very small for a country so vast in extent as California, the state having an area of 188,982 square miles, equal nearly to the areas of all New England, New York, Pennsylvania and Ohio, and but little less than that of France.

features of the mountain system of the state, Professor Whitney illustrates in the following manner.

In order to bring vividly before the mind the grand simplicity of the topographical features of California, we may draw on the map of the state five equidistant, parallel lines, having a direction N. 31° W., and 55 miles apart.

Let the middle one of these be drawn at the western base of the Sierra Nevada, touching the edge of the foot-hills, as it will be found to do, with the given direction, from Visalea to Red Bluff; the first parallel line east of this, drawn at 55 miles distance, will pass through or very near the highest points of the Sierra Nevada, beginning with Mt. Shasta on the north, and touching in succession, toward the south, first Lassen's Peak, then Spanish Peak, Pilot Peak, the Downeyville Buttes, Pyramid Peak, Castle Peak, Mt. Dana, to Mt. San Bernardino and San Jacinto, touching also the high group of peaks discovered during the explorations of 1864. This line, if straight, would pass very near the culminating peaks of the Sierras for 500 miles.

The next parallel east of this, (at the same distance of 55 miles), crosses a series of depressions, occupied by lakes and deserts. The Klamath, Wright, Pyramid and Walker lakes, Death valley, Soda lake and the sink of the Mojave lie on it.

The first line to the west of the central one will be found to follow very closely the eastern base of the Coast Ranges from near Kern lake, northward for near 300 miles.

The second line west, and last parallel, represents very nearly the coast line of the Pacific, or the western base of the Coast Ranges.

These lines divide the state into four belts of nearly equal width, which preserve their main physical features over about five degrees of latitude, and for a distance of 400 miles, which embrace the most important part of the state, comprising nearly the whole of the agricultural, and by far the most of the mineral districts. These belts are designated as follows, naming them from the east to the west: the Eastern slope, the Sierra Nevada, the great Californian Valley, and the Coast ranges.

He further divides the state into the Southern, Central, and Northern Divisions, by two lines at right angles to these parallels, the first passing through Fort Tejon, near the southern end of the great Central Valley, the other through Fort Reading, near the northern end. In this article we will only notice

The Coast Ranges.

These, as their name indicates, lie near the coast, and when seen from the sea, appear to form an almost unbroken wall rising directly from the water. They consist of a number of chains or ranges, known under separate local names; they are gene-

rally much inferior in height to the Sierra Nevada, yet the culminating points rise to perhaps 8000 ft. There are not, however, many points above 5000 ft. These chains, or ranges, although each is nearly distinct, are all connected, with the exception of the peaks which form the outlet of the great Central Valley, at the straits of Carquines and the Golden Gate. Both north and south of this, each separate chain, after being separated from its next neighbor by a valley of greater or less width, then joins some other chain lying nearly parallel, the whole system joining topographically with the Sierra Nevada at either end. In some of these valleys may be found the most fertile soil and lovely climate of this favored state, and these, with their adjoining lower hills, together with parts of the great Central Valley, contain nearly all of its agricultural lands.

Geologically, these Coast ranges are not known to contain any strata older than the Cretaceous. Certain it is that Cretaceous and Tertiary rocks make up the whole of the portion that has been examined. Both of these formations are more or less extensively metamorphosed, and almost everywhere have been greatly distorted since their deposition; and in places this disturbance is going on at the present time. Both volcanic rocks and granite occur, but neither forms a conspicuous part in the system as a whole. The volcanic, however, constitute a considerable mass near St. Helena, and the granitic in the St. Lucia. Considered geologically, it is believed that this system does not extend farther south than lat. 33°, nor north farther than lat. 41° 30′ or 42°. They lie almost entirely within a length of 550 miles; on either side of this they are feebly represented, and apparently die out at the limits mentioned.

In breadth they are remarkably uniform for over three hundred miles of the length, being about 55 miles wide; but each side of the middle they swell out to 60 miles or over.

There is no central axis, nor is there a dominant chain, to which the others are subordinate. We will therefore notice some of the details as briefly as possible, and then return to some of the generalizations deduced.

The Monte Diablo Range.—This range possesses peculiar interest, and was studied with more care than most of the others. It forms the eastern member of the series, lying south of the bay of San Francisco. It commences at the straits of Carquines, and runs in a southeasterly direction to Pass El Roble, a distance of about 220 or 230 miles. The range has no central ridge upon which are located the culminating points, but consists of a belt of irregular hills 20 to 35 miles wide, the higher points associated in groups. On the eastern side the base is well defined, sinking to the plain of the great Central Valley; but on the western side it receives several other chains which com-

mence distinct, but which finally become merged into the main mass. The chain is traversed by several depressions, separating the higher groups of peaks, and in these depressions are the more important passes. The following table shows the subdivisions, and the heights of the higher peaks of each group, and of the intervening passes.

Groups.	Highest point.	Name and height of next Pass south.
Monte Diablo,	Mt. Diablo, 3856,	Livermore Pass, 686.
Mount Hamilton,	Mt. Hamilton, 4440,	Pacheco's " 1470.
Panoche,	Mariposa peak, 3700,	Panoche " 2500.
San Carlos,	San Carlos, 4977,	Estrella " ?
Estrella,	?	Pass El Roble, ?

Monte Diablo, the culmination of the most northern group, is about 30 miles from San Francisco, and forms a most interesting and conspicuous feature, and by far the best known landmark, in the state. Although less than 4000 ft. high, its position is such in respect to the surrounding country that it can be seen for a great distance in nearly every direction; and from its summit the view is one of uncommon extent and beauty. The snow-covered Sierra Nevada is visible for more than 300 miles along its crest, and the whole area spread out before the eye is nearly 40,000 square miles.

The mountain consists essentially of a double arch of Cretaceous strata, highly metamorphosed near the crest; this metamorphic center embraces about six or seven square miles, entirely surrounded by unaltered Cretaceous, and this in turn is encircled by the Tertiary which rests upon it.

The metamorphism of the Cretaceous can be here well studied, and the passage of the Cretaceous shales into jaspers, and of sandstones into serpentines and other forms of rock, are seen to perfection. These metamorphic rocks bear a little gold, quicksilver, copper and iron, but perhaps neither in quantities or conditions of economical importance; and we may here state that this is the case with several other of the groups. There is no unmistakably eruptive rock, but an inconsiderable portion closely resembles it in character, and may prove eruptive.

Resting conformably on the metamorphic in some places, and passing into it in others, are unaltered Cretaceous strata, rich in fossils, many of which have proved to be new species, their descriptions having already appeared in the volume on Paleontology. In the upper members of this Cretaceous, on the north side of the peak, occur the beds of coal in which are the "Monte Diablo Coal Mines." The coal beds, as stated, are two in number (possibly more); they dip to the north at a considerable angle, and yield a very good quality of bituminous coal. The produce of the mines in 1864 was 37,453 tons, and a larger

quantity might be obtained. These are the only coal mines in the state of any considerable extent, in successful operation, although coal exists in several other places in similar geological position. Resting on these Cretaceous strata, apparently conformably, is an immense thickness of Tertiary, of Miocene and Pliocene beds, the latter passing gradually into the more recent formations forming the plains. If the Eocene exists here or elsewhere in the state, its presence has not yet been proved by fossils.

Lying west of this mass is a lower range of ridges known as the San Pablo hills, which are eight to twelve miles wide; they continue distinct from the main chain for over fifty miles, and then unite with the Mt. Hamilton group. Opposite San Francisco they are 1400 to 1700 ft. high, but farther north they rise to near 2000 ft. Between this and the main chain are two valleys, like basins; the drainage of one is north to the straits of Carquines; the other is drained through a break in the hills near the head of the bay, by a cañon, which will probably at some future time, furnish the available gap for the Pacific Railroad to reach the bay and coast, the low Livermore Pass being the most practical place for such a road to cross the eastern members of the chain. There is here the usual admixture of Tertiary, Cretaceous and metamorphic. In the northern part the unaltered strata form for some distance a well defined synclinal axis (see section p. 14); but farther south they are more broken and irregular. A belt of metamorphic runs nearly the whole length; and in several places eruptive rocks come through, but they do not appear to have exerted any considerable influence either on the elevation or metamorphism of the mass. West of this group lies the bay of San Francisco.

Passing south from Monte Diablo, at Mt. Livermore's Pass, low Tertiary hills, less than a thousand feet high, denuded with rounded outlines, and rather steep irregular valleys, make up the range. They are treeless, and with the exception of the early spring, when they are covered with the annual herbage, are very barren and desolate.

South of this lies the greater mass of the Mt. Hamilton group, little known except from the labors of the survey, and containing the highest point within sight of San Francisco, Mt. Hamilton, 4440 ft. Here the chain is wider and very rough, denuded into deep cañons; the whole center consists of metamorphic Cretaceous strata, which are so broken and contorted that all regularity of dip and strike are lost. Along its eastern edge lies a belt of unaltered Cretaceous, in places of most enormous thickness. At Arroyo del Puerto it is believed to be over 20,000 ft., the whole dipping to the east, and consisting of heavy beds of sandstone, with interstratified shales, and some conglomerates.

Fossils are not abundant, but are sufficiently so for a satisfactory determination of the age. Evidences of the enormous thickness of this formation, and also of that of certain members of the Tertiary, were found in other parts of the State.

Along the most of this group, the Cretaceous rocks extend to the base on the eastern side; but on the west, there are Tertiary, altered in places. The San José valley lies west of this group.

The metamorphic center of this mass is not broken on the south, but extends along the chain to an unknown distance on the southeast, certainly beyond San Carlos, and probably much farther, or over 150 miles. No eruptive rock is known in this group.

In the next group south, the Panoche group, there are a number of peaks of eruptive rock, which are its culminating points. Pachecos peak is the most conspicuous, although not the highest, being but 2845 ft., the highest points being about a thousand feet higher. Antimony occurs in this part of the chain, but has not been turned to economical use. West of this group lies the San Juan valley.

Near the line of the next depression south, the Panoche Pass, there are remarkable evidences of the lateness of the disturbances; for Post-tertiary gravels are elevated at various angles, in some places nearly vertical, and have the great thickness of nearly two thousand feet; the deposit is rather local, and appears to have been formed in a closed valley, which has since been drained, and the gravels denuded and in places greatly disturbed.

The next group south of this, the San Carlos group, is the greatest of the chain, both as regards magnitude of mass and of altitude. Tertiary and Cretaceous rocks occur unaltered along its eastern side; the whole center is of metamorphic rock, so far as is known: the character of the western side is unknown. This group has not been extensively examined. It is very rough, barren and forbidding, and near the eastern edge of the metamorphic the New Idria quicksilver mines are located. These mines attracted at one time much attention, and have yielded a considerable quantity of the metal, but they have not as a whole proved eminently profitable. The ore is much scattered, and occurs at intervals of several miles, the two principal mines being the New Idria, and the San Carlos. An immensely large vein of pure chromic iron occurs in the vicinity.

South of this nothing is definitely known of this chain, further than that it is very rough; that it decreases in width and altitude as we approach its southern end; that it apparently receives another range of hills that crosses the Salinas valley below the San Antonio river; that the hills along its eastern margin grow more dry and barren south of the Pachecos Pass; and that in the Estrella Pass and Pass el Roble, Tertiary fossils have been

found by the Pacific Railroad surveyors. This last pass is very low, and terminates the chain under a distinct name, the hills here joining the larger chain that stretches west from Fort Tejon.

We have noticed this chain more at length, because, in some respects, it is typical of the Coast Range as a whole; without any central axis, without any great intrusions of eruptive rock, it is a broad belt of elevated country, rather than a ridge. Valleys extend up in it, and closed basins occur in it, with but a narrow outlet, of which the Livermore, Suñol, and Panoche valleys are the most marked. On its western side it receives several other chains which enter it at a sharp angle from the northwest, and such ridges enter each group except the northern.

In short, the chain appears to have been elevated by forces acting along two different directions, the principal one nearly parallel with the chain, giving it its general direction; while others, acting diagonally to the first, modified its shape, and gave rise to the *groups* we have noticed, nearly every one of which is on the line at which another chain enters, and produced the peculiarities of dip and strike which are described with considerable detail in the work, but which we here necessarily omit.

While no chains of mountains pass off from the main chain on its eastern side, yet the strata show a great tendency to pass out and sink beneath the San Joaquin plain, the strike being nearly parallel with the direction of the chain, but diagonal to it, great masses passing out opposite each group, while in the center of all of the groups examined, except that of Mt. Diablo itself, the metamorphic rocks have every possible dip and strike. Although the chain may be considered a unit geographically, it is not so geologically. Aside from its union with the chain on the west, already noted, it is separated to the northwest, by the narrow strait of Carquines from ridges of the same age and general character, while on the south, it blends with other ranges; only its eastern edge seems to be well defined, where it everywhere sinks into the dry San Joaquin plain.

The great mass of the chain is Cretaceous, and the most of this is metamorphosed; the Tertiary plays but a subordinate part, and the disturbance of the strata have continued to the latest times.

Economically considered, the chain has no great sources of wealth. The soil is mostly barren; but valleys of limited extent, especially in its northern part, are very fertile and many of its lower hills afford pasturage to limited herds and flocks. No forests occur in any part of its length, but the center is covered with scattered timber or chapparal, and scattered trees occur on some of the lower hills. Coal is its most valuable mineral, and this occurs in workable conditions only at its northern portion, near Mt. Diablo. Quicksilver occurs in many localities, from

Mt. Diablo to San Carlos, and considerable quantities have been mined at and near the latter locality; all the others seem unpromising. Copper occurs in very numerous localities, and has been the subject of several mining "excitements," but thus far no well defined vein has been found, nor has a single deposit been profitably worked. Chromic iron occurs also in several localities; one vein near New Idria is of great size, but it has thus far been turned to no account. Antimony occurs near Pachecos peak, but is not worked. Silver has been reported several times, and some mining excitements have been raised, but the labors of the prospectors have not been rewarded. Gold occurs at very numerous localities, but at all in too small quantities to be profitably worked. Hydraulic cement occurs in the Cretaceous shales, and near Martiñez may yet be turned to account; but thus far it is not worked. Asphaltum and oil occur near the two extremities of the chain, but thus far they do not bid fair to be profitable.

North of the bay of San Francisco, we have a continuation of the Cretaceous, also mostly metamorphosed, being a system of ridges and hills, occupying the region between the ocean and the Sacramento valley, and mostly without the wide valleys so common south. Russian River, and Napa valleys are similar to those, but narrower. The metamorphic Cretaceous bears the same mineralogical and lithological features, and quicksilver occurs in many localities, in some of which it has been worked, but thus far with questionable profit. It occurs generally as the sulphuret, but considerable quantities of the native metal are found in certain localities in Lake county.

There is a smaller proportion of unaltered rock than in the ranges south of the bay, and a larger of volcanic material. Near the sea, along the western members of the group, Miocene Tertiary rests unconformably on the highly disturbed and altered Cretaceous, but the extent of the formation is rather limited. Gold has been found in numerous localities, but never in sufficient abundance to be of importance. Numerous warm springs occur, some of which are celebrated for their medicinal qualities, and the so-called Geysers are widely known as objects of scenic interest. A small lake near Clear Lake, is yielding borax in considerable quantities to commerce. Some of the valleys are among the most fertile and beautiful of the state.

Between the bay of San Francisco and San José valleys on the east and the Pacific on the west, and extending from the Golden Gate to the bay of Monterey, are a series of ridges known under a variety of local names, the principal of which are the Peninsula of San Francisco, the San Bruno hills, and the Santa Cruz mountains. This series is about 75 miles in length, and has a maximum width of about 25 miles. They begin quite narrow and

low on the northwest, and increase in height and breadth to near New Almaden, where they attain their greatest breadth, and above Mt. Bache, 3780 ft., is the culminating point, then decrease to the southward. These ridges rise directly from the sea, without intervening plains along the coast.

In this series, the Cretaceous strata, so far as seen, are mostly altered and very much broken and contorted, and Tertiary rocks, mostly of the later groups, are largely developed. The formations which compose these ridges on the north are but a continuation of those found in Marin Co., on the opposite side of the Golden Gate and on the south, and they throw out spurs, one of which apparently crosses the San José valley by a series of hills of highly metamorphic rock a few miles below San José, and again by ridges near the southern part, which cross the Pajaro river, and connect with the Gavillan range, which series are in turn absorbed by the Monte Diablo range farther east.

Beginning at the north, the most of the rock in and about San Francisco is of highly altered Cretaceous, so broken and contorted that no prevailing dip or strike can be observed. These constitute the rocky hills in the city, and about it, and also the most of the rocky islands in the bay. The rocks have precisely the lithological character of the rocks of similar age in the Mt. Diablo group, and a few fossils have been found to fix the age beyond cavil.

In places, beds of Pliocene rest unconformably on them. As we proceed northward, the Miocene comes in, and throughout the rest of the range plays a more conspicuous part.

By far the most interesting feature of this group, is the great abundance of cinnabar at and near the New Almaden mines. So much has been written about these mines, that an extended description here is unnecessary, except to say that the labors of the survey appear to have demonstrated that they lie wholly in metamorphic Cretaceous rocks.

Cinnabar occurs in limited quantities in many localities in these beds, from the city of San Francisco to near the Pajaro river, always associated with rock of such peculiar character that it is readily recognized by the explorer familiar with the coast ranges, and precisely similar to that in which the same ore occurs at New Idria, San Carlos and other mines, Monte Diablo, San Pablo hills, and the very numerous localities in Lake and Napa counties, the most of which are certainly in the Cretaceous.

The greatest deposits of ore, so far as is known, are at New Almaden, where these well known mines have a capacity of production at present of about 5,000 flasks per month, or four and a half millions of pounds per year.

The Enriquita mine is now merged in the New Almaden, or is worked by the same company. The Guadaloupe mine has

furnished considerable of the metal, but vastly less than the New Almaden. These three mines lie on a ridge—the culminating points of which are about 1,600 to 1,700 feet high,—lying east of the main mass of mountains. Traversing this ridge are a series of limestones, which may be traced much farther in each direction. Serpentine in large quantities, and bitumen in small quantities, are associated with the cinnabar in all of its localities. Prospecting has been largely prosecuted in both directions without important results.

A mass of Tertiary is folded between this ridge containing the mines, and the main mountain range west. This is seen in limited quantities back of Mine peak, and it occurs again much more largely to the northwest. Whether the larger masses of Tertiary, lying in front of the main chain both to the northwest and southeast, are continuous along a belt behind the Mine ridge, is not demonstrated; the strata are so broken, that much more labor is needed before the details of structure can be known.

The mountains back of the Mine ridge of New Almaden are peculiarly rough and forbidding; many points rise to above 3,000 ft., and the region is denuded into deep and precipitous ravines. The slopes are covered in some places with scattered timber, in others with a dense growth of chapparal or chamisal, making exploration laborious.

On the western side altered limestone again occurs, but its extent is not known. Quarries in this rock near Santa Cruz supply the most of the lime used in the San Francisco market.

Between the summits and Santa Cruz on the south, large masses of Tertiary occur, slightly disturbed near the bay, but much broken farther back. Five terraces near the coast indicate changes of level at no very remote period geologically.

Granite occurs, in comparatively limited masses, at various places in this chain, as well as in its continuation north of the Golden Gate, in Marin Co., and of the same character, generally highly decomposable. Its precise relation to the other rocks has not been studied. Near the southern end of the large mass, and a few miles north of Santa Cruz, gold has been found in sufficient quantities to pay at times for working on a limited scale. One mass of gold-bearing quartz was worked with a profit for a very short time, but it soon ceased to pay. Elsewhere in this range gold has been found in small quantities, generally on the metamorphic portion, and we have heard it repeatedly stated that it may be detected in certain of the sands in the city of San Francisco itself.

Unsuccessful exploration for coal in workable quantities has been carried on at various times, and at various points, and more recent explorations for oil have thus far also been unsuccessful.

With regard to the entire region south of the bay of Monterey, and belonging to the coast ranges, less can be said, because less is known, either geographically or geologically. A mere reconnoissance has been made of a part of it, while of large areas we are wholly in the dark, as neither the explorations of the Geological Survey, nor of other exploring expeditions have there penetrated. We will notice, however, some of the more salient features.

Santa Lucia chain.—Beginning at Point Pinos, at the southern entrance of the bay of Monterey, commences another chain that follows the coast closely, for about a hundred miles, to Estero Bay, along a curve, which continued carries the chain from the coast at this point more to the eastward, until it connects with other chains which extend on in an unbroken series until they join the Sierra Nevada near Fort Tejon, 140 miles beyond. The main portion of this chain takes the name of *Santa Lucia*, but portions of the range, and spurs that branch from it, take local names.

The chain attains a width of 20 to 25 miles for a considerable distance, and in places is even wider. Its western base, for a hundred miles, sinks directly into the ocean and is peculiarly inaccessible, and both its geography and geology are entirely unknown, except the general features of the coast line. On the eastern side, for 120 miles, stretches the valley of the Salinas, separating it from the Monte Diablo range. Granite commences at Point Pinos, and occurs at intervals along the northern twenty or thirty miles, and is known to form large masses in the interior of the chain. For this portion, the rocks consist of this granite, metamorphic Tertiary, and unaltered Miocene and Pliocene strata, and in places limited eruptive rock. No Cretaceous beds have been found to exist here, but they are believed to occur farther within the chain.

The Carmelo valley cuts the chain from the northwest, and on its west side is a high range of hills known as the Polo Scrito hills, made up of metamorphic rock, including gneiss, dipping northeast, and containing some granite.

The highest part of the chain lies near lat. 36° N., where the mountains attain a height supposed to be 5,000 ft., or more, and over this region the country is especially difficult of access. The scarcity of water on the ridges, the density of the chapparal, the precipitous nature of the slopes, the absence of all roads and trails, and the ferocity of the wild beasts, have thus far deterred explorers. For nearly a hundred miles, along its western base, Tertiary rocks occur, often of great thickness, generally dipping away from the main chain, but often greatly twisted and contorted. These strata, so far as is known, are Miocene and Pliocene; but in the metamorphic, toward the center of the chain,

Cretaceous strata are believed to occur. Portions of the Tertiary are highly bituminous, and asphaltum is often met with.

Gold occurs in small quantities, especially on the San Antonio river, and there have long been traditions of silver mines in the interior.

A range of Tertiary hills, known as the San Antonio hills, branches from the main chain, and crosses the Salinas valley about 75 or 80 miles from its mouth. Above this, are great deposits of modern gravels, lying horizontally, and in places most beautifully terraced.

From north of San Luis Obispo, we have a section of the rocks given (p. 144) which differs most remarkably from the supposed structure of the chain, as described by previous authorities. Instead of an anticlinal axis, having an eruptive center, with regularly arranged strata on the two sides, we have a fan-like structure, suggesting a synclinal axis; but the position on the north side of the chain is not given. With respect to the region east of this point we have no data.

South of San Luis Obispo, there is a lower range of hills, having also the fan-structure, shown on the same section; while between these chains are more or less isolated hills of serpentine and other kinds of metamorphic rock.

Between San Luis Obispo and Los Angelos, there is a succession of ridges having a more nearly east and west direction, separated by comparatively narrow valleys. Between the Santa Lucia and Santa Iñez chains, we have about two principal chains, of which we know little as to the details of their structure. So far as is known, they are composed almost entirely of Miocene and Pliocene strata, in places of immense thickness. There is much metamorphic rock, but little if any eruptive. It is believed that Cretaceous strata occur on the north of the Santa Iñez chain, but of this we have no proof. The strata are everywhere much broken and disturbed, and the details of structure very much complicated. In the valleys there are occasional stratified deposits of more modern age resting on the upturned Tertiary. The member of the Tertiary known as the "Bituminous slates" is largely represented, and asphaltum and its kindred bituminous substances are of frequent occurrence.

The Santa Iñez chain.—The Santa Iñez chain begins at Point Conception, and stretches nearly east, joining in that direction the other chains that pass south of Fort Tejon, toward San Bernardino. Only the western part has been examined. Here it stretches in an almost unbroken ridge, the Gaviote pass being the only gap for many miles. The chain attains a height of near 4,000 feet east of Santa Barbara, but decreases in height toward the west to about 2,500 feet at Gaviote pass. So far as is known, the western end of the chain is composed entirely of

Tertiary sandstones, of the Miocene age, scarcely altered. The structure of the chain is somewhat remarkable.

At the Gaviote pass, the strata all dip to the south, presenting their broken edges to the north in a very conspicuous manner as we enter the pass from this direction. Twenty miles farther east, back of Santa Barbara, they still dip north, but at a higher angle, the broken edges of the uplifted beds forming a very ragged and most picturesque outline against the sky, the southern slope being very steep. A short distance farther east there is an anticlinal axis, of which the crown or northern portions are much removed, while at the most eastern part the strata have all a northern dip, and the chain a broader summit. It is in fact as if an anticlinal axis crossed the chain at an oblique angle; at the western end the northern side of the arch being wanting, and at the eastern end, the southern being removed, or inconspicuous.

At and near Santa Barbara, the crest of the chain consists of the thick sandstones; resting on these are the bituminous shales which become much broken and contorted in the Fort hills and near the sea. Both of these formations are remarkably non-fossiliferous; but few species were found. Resting on the worn and contorted edges of the bituminous shales, are more modern Pliocene and Post-pliocene deposits, nearly horizontal, and in places very fossiliferous. For sections of these strata, the reader is referred to the illustrations in the volume.

The bituminous shales yield much bituminous material. Asphaltum and oil occur in great quantities and at many localities, sometimes seen oozing directly from the shales, at others, filling cavities in or saturating the looser superficial deposits. Quicksilver has been reported since the date of these explorations in the mountains to the northeast of Santa Barbara, in rocks of Tertiary age.

Between the Santa Iñez and Santa Monica chains are a series of minor ridges, very much broken in their character, composed of Tertiary rocks, so far as is known, very complicated in their details of structure, of which we have only very limited information. The Santa Susanna range is the most considerable, rising on the north of the San Fernando valley, to the height of 3,000 feet. It is composed of beds of sandstone of immense thickness, very non-fossiliferous, which are overlaid by the bituminous shales that extend north into the valley of the Santa Clara river, all dipping to the north. There are evidences of an immense fault, and the San Fernando valley occupies the line of the break. The broken edges of the thick sandstone strata, presenting a rocky and precipitous front to the south and rising like a gigantic wall from the plain, are conspicuous and grand objects in the scenery of the region. The fault must be great, for the hills rise to at least 3,000 ft., the upper members being of

the same series that sink beneath the plain on the south side, from the northern flanks of the Santa Monica.

The chain known as the Santa Monica is of less extent, its western end terminating in a bold headland on the Pacific. The length of the chain is about 36 miles, and it is about six miles wide toward its eastern end; but at its western it becomes mingled with the mountains that close around the western end of the San Fernando valley. The chain is especially interesting from its having a well-defined anticlinal axis, with a mass of granite forming the center, the strata dipping away from its center on either side. In places they are altered quite extensively, especially near the contact with the granite. The strata consists of both the sandstones and the bituminous slates of the Miocene age.

Of the chains south of this we have less information. The San Gabriel range is high and very rough, and rises abruptly from the San Gabriel plain to a height of over 6000 ft., a most picturesque object in the landscape. It is but little known geographically and geologically. It appears to be made up mostly of granitic and metamorphic rocks, and to have been elevated since the Cretaceous period, and hence to belong to the Coast Ranges, although it connects with the San Bernardino chain, which belongs to the series, as do the other chains of the Coast Ranges with the Sierra Nevada near Fort Tejon. Strata supposed to be of Tertiary age, of great thickness, lie along the southern flanks, which have been greatly disturbed and are traversed by numerous dikes of granite. The whole of this side of the chain shows most extensive disturbances and powerful metamorphic action to have taken place since the deposition of the Miocene.

The region south of this is also little known. The ranges known as the Santa Anna chain and the Temescal range were visited. The latter has attained some celebrity from the existence of tin ore in it, forming the so-called Temescal Tin Mines, which were the scene of considerable excitement five years ago. Enough tin ore has been found here to justify some hopes of its occurring in paying quantities; but thus far explorations have not been rewarded by any deposits of workable value. The geological age of the rocks in which it occurs has not been satisfactorily determined.

The islands that lie off the lower coast, at least the more northern of them, appear to be of the same age as the Coast Ranges, and to belong to the same periods of elevation.

The only other portion of the Coast Ranges that is treated of at any length in the volume before us is that lying to the south of the Tulare valley and closing around the head of it, uniting with the Diablo and other Coast Ranges on the west, and with the Sierra Nevada on the east, forming a perfect topographical

connection. This is of special interest on two accounts: first, the geographical union of these chains of unlike geological ages; and secondly, because here Eocene strata have formerly been supposed to occur. This belief arose from fossils supposed to be Eocene found in a boulder near the Cañada de las Uvas, by one of the parties of the Pacific R. R. Exploration. The localities whence this boulder must have been derived was examined and found to be most unmistakably Cretaceous, a large number of characteristic fossils being found. At San Emidio Cañon these Cretaceous strata are of inconsiderable thickness compared with the enormous thickness of Tertiary that rests conformably upon them.

Some of this Tertiary would appear from position to be Eocene, but no unmistakable Eocene fossil has yet been found in the state. Certain fossils found near New Idria are of uncertain age, and Mr. Gabb inclines to the belief that they may be Eocene. Antimony occurs in at least one place, and there has been much useless prospecting for silver.

In the mountains to the south there has been "copper excitements," but thus far with no valuable results; and gold has been washed to some extent, and we believe it still is worked. The first gold extracted in California was found as early as 1841, in the region between this range and San Fernando valley.

We have thus glanced rapidly at some of the more interesting features of the Coast Ranges; we will now briefly review some of the generalizations.

We find in these chains every variety of structure. In the Santa Monica a well defined anticlinal axis; in the San Luis Obispo hills, in the San Pablo hills, and in other places, synclinal axes; in the Santa Susanna range a great fault, the broken edges of the strata forming one flank, the plane of the strata the other; in Mt. Diablo a double arch; in other groups of the Diablo chain a crumpled mass of strata. We see that the chains have been elevated by forces acting in directions transverse to each other; that these have not only determined the direction of the chains as a whole, but have modified the structure of each. These complications of structure, aided by most extensive denudations, have resulted in the peculiar topography of the region. It appears that the forces acting along the northwesterly and southeasterly directions have been the strongest, and hence have determined the directions of the larger chains, as well as the general direction of the coast.

Changes of level have taken place down to very modern times, and have even accompanied the earthquakes of recent years. Hot springs are numerous and occur along nearly the whole length of the chain and in many of the ranges.

In regard to the metallic and mineral wealth, we may review what has been already stated.

Quicksilver is the most valuable metallic product. Its place of greatest abundance is at New Almaden; but it occurs in numerous other places in metamorphic Cretaceous, but generally in quantities or under conditions which have forbid its profitable extraction. Gold occurs in very numerous localities, but has not repaid working except in a few rare instances and on a small scale. Silver has been reported at various times, but no mines of value have yet been found. Copper occurs in very numerous localities, but thus far no vein containing workable quantities of ore is known. Iron, tin, antimony, and manganese ores have been found in limited quantities, but not in conditions of commercial importance. Chromic iron occurs in large quantities, but also valueless. Coal occurs in workable beds at Monte Diablo, and in less quantities and under less favorable conditions at other places. Asphaltum occurs in immense quantities, and oil has been obtained, and extensive explorations have been made for the latter with reference to wells of commercial importance, but thus far unsuccessfully. Borax is extracted with success at one place, and sulphur occurs in some places which may hereafter prove of value.

The mountain ranges and their valleys are without forests except on the immediate coast, but the most of the hills have scattered trees. The higher ridges are very barren and dry, the lower hills yield pasturage, and the valleys are often very fertile, some of them possessing the finest climate as well as the most fertile soil of the State.

We will consider the Sierra Nevada in a future article.

W. H. B.

ART. XXXIV.—*Contributions from the Sheffield Laboratory of Yale College.* No. X.—*Mineralogical Notices;* by GEO. J. BRUSH.

1. *On Cookeite, a new mineral species.*

ASSOCIATED with the tourmaline and lepidolite of Hebron and Paris, Maine, there occurs a pearly micaceous mineral somewhat resembling *nacrite.* In searching for amblygonite on the Hebron specimens of lepidolite, Professor Cooke of Cambridge, some three or four years since, discovered that this substance had very remarkable pyrognostic characters. Before the blowpipe it exfoliates like vermiculite or foliated pyrophyllite, at the same time imparting an intense lithia-red color to the flame. Professor Cooke called my attention to this mineral at the time of his observation of its properties, but it was not until I visited the locality in 1863, that I obtained the mineral in sufficient quantity and purity to make further investigations in regard to it.

It is found coating crystals of rubellite, and appears to be a

product of the alteration of this variety of tourmaline; in many instances cavities in the rubellite are filled with the nacreous substance. It is also intimately associated with lepidolite, sometimes in extremely minute scales, and not unfrequently in hemispherical aggregations; more rarely it is found in distinct six-sided prisms, which are bent into a vermicular form like some varieties of chlorite. In most cases it occurs so mixed with the tourmaline and lepidolite as to preclude the possibility of its being selected free from these minerals.

Its characters are as follows. Color white, in some cases yellowish-green, in thin scales transparent. Luster pearly, eminently so on the cleavage plane. Structure micaceous. Hardness 2·5. Specific gravity 2·70. In the closed tube, gives off much water, and, on treatment with the blowpipe flame, swells up and exfoliates in a remarkable manner, sometimes bursting the tube. The water which is first given off is neutral, in some cases where the mineral has been weathered it is even feebly alkaline; at a higher heat, however, it affords a small amount of fluorid of silicon, and this on contact with the water deposits a faint ring of silica and gives the water an acid reaction. The tube is also slightly dimmed or etched from the action of the fluorine. Before the blowpipe in the forceps, the mineral exfoliates like vermiculite and colors the flame beautifully carmine-red; it fuses on the thin edges, and with cobalt solution gives a blue color. With salt of phosphorus, gives a skeleton of silica. It is partially, if not completely, decomposed by sulphuric acid.

The limited amount of pure mineral at my command prevented as thorough a chemical examination of it as could be desired; but from a qualitative analysis it proves to be a hydrated silicate of alumina, lithia and potash, with only minute traces of soda. The alumina has some anomalous properties, and at first suggested the presence of some other substance which had escaped identification. When thrown down by ammonia, it seems somewhat less bulky and floculent in its character, and is much more easily washed than is usual with alumina; it, however, reacts blue when treated with nitrate of cobalt, and with the small quantity under examination I have been unable to identify the presence of any other element. It was completely soluble in potash and was insoluble in carbonate of ammonia, and did not react for either fluorine, boracic or phosphoric acids. Its sulphate, when treated with sulphate of potash, yielded octahedral crystals of alum.

The quantitative examination has been made by Mr. Peter Collier, assistant in this laboratory. For analysis, the mineral was ignited, then fused with carbonate of soda to determine the bases, and with carbonate of lime and chlorid of ammonium to determine the alkalies. The lithia was in one instance determined directly, and in the second case by difference, the potash

being weighed as platin-chlorid of potassium, and the amount deducted from the total chlorids. The water was determined by igniting the mineral with perfectly dry oxyd of lead, and the difference, between this loss and the total loss on igniting the mineral alone was considered to be fluorid of silicon. Analyses:

	1.	2.	3.	4.	5.	6.	Mean.
Hygroscopic moisture, expelled at 100° C.	·40	·39	·36	....	....	....	·38
Water, - - -	13·89	13·87	13·89	....	....	....	13·41
Fluorid of silicon, -	....	....	....	....	.. .	0·47	0·47
Silica, - - -	35·04	34·05	35·71	....	....	....	34·93
Alumina, with a little iron, - -	45·11	45·28	44·35	....	....	....	44·91
Potash, - - -	....	....	....	2·57	....	....	2·57
Lithia, - - -	....	....	....	2·84	2·81	....	2·82
							99·49

The oxygen ratio of the $\dot{R}, \dot{H}, \dot{S}i$ and $\dot{H}$ is 1·93 : 20·97 : 18·51 : 11·91, or approximatively 1 : 10 : 9 : 6, indicating a composition between that of euphyllite and that of margarite. The composition here given is as accurate as was possible to obtain with the small amount of the substance operated upon. The physical and the pyrognostic characters alone are enough to prove the mineral to be a new species, and as such I take pleasure in giving it the name *Cookeite*, after Professor Josiah P. Cooke, Jr., who I believe was the first to discover its remarkable pyrognostic characters.

2. *Jefferisite, a new mineral species.*

In the Ninth Supplement to Dana's Mineralogy, I described a chloritic mineral, which I referred with a query to *vermiculite*.[1] It is the well known brownish chlorite-like mineral from the serpentine quarry near Westchester, Penn., and like the preceding mineral exfoliates in a very characteristic manner when heated. I have recently learned, through Professor Dana, that Des Cloizeaux has determined vermiculite to be uniaxial in its optical characters, and consequently hexagonal in crystallization; and as the Westchester mineral is optically bi-axial, as stated in my first description of the mineral, it must form a distinct species. I propose for it the name *Jefferisite*, after the well known collector, Wm. W. Jefferis, Esq., of Westchester, the original discoverer of the mineral.

I have recently received from Mr. Raphael Pumpelly a similar mineral from Japan, possessing the same property of exfoliating when heated. Mr. Pumpelly informs me that it is found in the mountains of the Peninsula of Kadzusa, southeast of Yedo, and that it is used as an object of amusement by throwing it on coals. The specimens he has sent are small six-sided prisms, two or three lines in diameter. They have a brownish color and are very similar in physical and pyrognostic characters to Jefferisite.

[1] For the physical characters and chemical composition, see this Journal [2], vol. xxxi, p. 369.

ART. XXXV.—*Note on the Distribution of North American Birds;* by A. E. VERRILL.

ON page 87 of this Journal, Prof. Baird has referred to some observations made by me, in a paper published in the Proceedings of the Essex Institute, vol. iii, page 136, in regard to the division of the Eastern Ornithological Province into Canadian and Alleghanian Faunæ.

Since the publication of those observations they have been confirmed by many additional facts, and the boundaries have been more exactly defined, though not materially changed. In endeavoring to ascertain the *physical* causes which thus influence the distribution of birds in latitude, I have found that the essential limiting cause is the average temperature of the breeding season, which for the majority of our birds may be taken as April, May and June. A line drawn upon the map of eastern North America representing the mean temperature of 50° F., during these three months, will coincide with the southern boundary of the Canadian Fauna, as previously determined from the examination of the birds breeding in that subdivision. Another line representing the temperature of 65° will represent the southern boundary of the Alleghanian Fauna as distinguished from the Louisianian or Gulf State Fauna, which has also been admitted by Prof. Baird and others, from the characteristic birds of the two regions. This line commences on the Atlantic coast near Portsmouth, Va., thence passes up the valley of the James River to near Gordonsville, but on approaching the mountainous region it turns southward through North Carolina and Western Georgia, and, passing along the southern flanks of the Appalachian mountain system, turns to the north again, passing through Tennessee and Kentucky, and up the valley of the Mississippi, probably beyond Cairo, and along the lower part of the Ohio valley. Cincinnati seems to be just north of the line, its temperature varying in different years between 64° and 65°. Beyond the Mississippi valley I have not had data sufficient to determine either of these lines, but that of 50° seems to cross it in the vicinity of St. Paul, Minn. The Gulf State region may be considered, also, as bounded on the south by the line of 80°, which would leave the southern part of Florida as a peculiar subdivision, as suggested by Prof. Baird.

Whether corresponding facts exist in the Middle and Western Provinces can only be determined by future observations, both ornithological and meteorological, but analogous facts would lead us to suppose that the same law will hold in all temperate regions at least, although it may be less apparent. Thus it has

been observed both in Europe and America that the temperature of the flowering and fruiting season mainly controls the distribution of plants in latitude. The line of 65°, average temperature during June, July, August and September, indicating the northern limit of the grape culture, at the same time is nearly coincident with the northern range of various other plants. And in this country the same line agrees very nearly with that of 50° determined for April, May and June. It is, therefore, evident that the distribution of the birds may be very similar in some respects to plants, and consequently to insects and other animals dependent upon them for food, even though not depending upon precisely the same season.

The discovery long since made by Prof. Dana that the Crustacea are influenced in their distribution in latitude mainly by the temperature of the winter months is evidently connected with the same law.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the influence of the electro-negative elements upon the spectra of the metals.*—DIACON has published an interesting paper upon the influence of chlorine, bromine, iodine and fluorine upon the spectra of various elements and has confirmed and extended the results of Mitscherlich. The memoir is preceded by a good historical introduction, and is illustrated by four excellent figures of spectra. The author sums up his results as follows:

The chlorids of certain metals which are very rapidly decomposed in the gas-flame are at least partially volatilized in a chloridizing flame and are therefore capable of producing spectra. These spectra in general differ from those which are observed with the oxyds of the same metals in an oxydizing flame.

The chlorid, bromid, iodid and fluorid of the same metal, placed in an oxydizing flame may give rise to bright lines, the position of which is different according to the salt examined. These lines, the duration of which is very variable, are always accompanied by the spectrum which we obtain with the oxyd.

Since the lines which appear with the chlorids belong to spectra which characterize these salts when volatilized in a chloridizing flame, it is proper to consider the new rays which are presented by the bromids, iodids and fluorids, as forming part of the spectra which these compounds would give in flames which do not act upon them. Hence it follows that if it were possible to make with these salts experiments similar to those made with the chlorids, we should have for the same element, barium for instance, five different spectra.

Diacon considers the influence of the electro-negative element upon

the spectrum to be placed beyond a doubt by his experiments as by those of Mitscherlich. The spectra given by Bunsen and Kirchoff for the alkaline-earthy metals are mixtures of the spectra which are obtained when the oxyd is ignited in an oxydizing flame, and those obtained by igniting the chlorids in a chloridizing flame. The spectra attributed by Mitscherlich to the chlorids are also in part mixtures of the same spectra. In the first case, however, the spectra of the oxyds predominate, and in the second those of the chlorids.—*Ann. der Chimie et de Physique*, t. vi, 4th series, p. 5. W. G.

2. *On hydroxylamine.*—Lossen has succeeded in replacing an atom of hydrogen in ammonia by an atom of peroxyd of hydrogen or hydroxyl. The new ammonia is formed by the action of tin and chlorhydric acid upon nitrate of ethyl. The author employs a mixture of five parts, by weight, of nitric ether, 12 parts of tin, and 50 of chlorhydric acid of spec. grav. 1·124. The mixture becomes strongly heated after a short time, but not much hydrogen is evolved. When the action is over the tin is removed by sulphydric acid and the liquid concentrated by evaporation; large quantities of salammoniac first crystallize out, and afterward the chlorhydrate of hydroxylamine, which is very easily soluble in water. This may be completely separated from salammoniac by dissolving the mixed salts in absolute alcohol and precipitating the salammoniac by bichlorid of platinum, which does not combine with the chlorhydrate of hydroxylamine. Leaving the ethyl out of consideration the formation of hydroxylamine may be represented by the equation

$$NH\Theta_3 + 6H = NH_3\Theta + 2H_2\Theta.$$

The chlorhydrate of hydroxylamine crystallizes from a hot saturated solution in alcohol in needles or in broad leaves; its formula is $NH_3\Theta \,.\, HCl$. The sulphate has the formula $2NH_3\Theta \,.\, H_2S\Theta_4$. The nitrate could not be obtained crystallized; the oxalate crystallizes in beautiful prisms which have the formula $2NH_3\Theta \,.\, C_2H_2\Theta_4$. It is not yet decided whether hydroxylamine can be prepared pure in the isolated state. When a concentrated solution of a salt of this base is treated with caustic potash, nitrogen is given off rapidly and ammonia is formed. The decomposition may be represented by the equation

$$3NH_3\Theta = NH_3 + 2N + 3H_2\Theta.$$

In dilute solutions the decomposition takes place gradually. When sulphate of hydroxylamine is precipitated by baryta water a more stable solution of the oxyd is obtained. This may be boiled without rapid decomposition; by distillation a part of the hydroxylamine passes over with the vapor of water. When chlorhydrate of hydroxylamine is rubbed with oxyd of copper a slow evolution of gas takes place, and in this gas deutoxyd of nitrogen may be detected.—*Monatsber. der Berliner Akad.*, S. 359, July, 1865. Quoted in *Chemisches Central Blatt.*, No. 61, p. 970. W. G.

3. *On a new sulphid of Carbon.*—Löw has described a new sulphid of carbon obtained by the action of an amalgam of sodium upon the bisulphid. When semi-fluid amalgam of sodium is shaken with bisulphid of carbon in a well corked bottle the temperature of the mixture rises, and the process is complete when after repeated addition of the

bisulphid heat is no longer evolved. If the mixture be then thrown into water a blood-red solution is formed, which, after filtering, contains much mercury; by passing sulphuretted hydrogen for some time into the solution this may be removed. The dark red solution is then to be poured into dilute chlorhydric acid with constant stirring. A flocky red substance is separated which aggregates to a tough resin, while much sulphuretted hydrogen is given off. The resinous mass is to be washed continuously with hot water as long as it smells of sulphuretted hydrogen. On cooling it becomes brittle, and then yields a violet-brown glistening powder which may be purified by solution in bisulphid of carbon, filtration and evaporation. The new sulphid is but slightly soluble in alcohol and ether, but is readily soluble in bisulphid of carbon with a red color. It dissolves in the pure alkalies, as well as their carbonates, with partial decomposition, but appears to be taken up by alkaline sulphids without alteration. Concentrated sulphuric acid dissolves it with a red color and water precipitates it from this solution. Nitric acid of 1·5 attacks it violently and appears to form a new acid. Heated in a closed tube to 100° the new sulphid melts to a tough resin and remains in this state after the temperature rises to 150°. Sulphuretted hydrogen is then given off. At 200° an amorphous yellow body sublimes and on further heating much voluminous carbon remains. Analysis gave for the new body the formula C_2S_3H. The author explains its formation by the following equations:

$$\text{I. } 2C_2S_4+NaHg=2NaC_2S_3+NaS.HgS.$$

$$\text{II. } 2NaC_2S_3+NaS.HgS+HS=2NaC_2S_3+NaS.HS+HgS.$$

$$\text{III. } 2NaC_2S_3+NaS.HS+3HCl=3NaCl+2HS+2HC_2S_3.$$

Löw regards the body C_2S_3 as a radical analogous to cyanogen or methyl. The compounds of this radical with the alkaline metals are dark-red to black and easily soluble in water; those with the heavy metals are brown or black precipitates.—*Chemisches Central Blatt.*, Nov. 8, 1865, p. 941; from *Wittstein's Vierteljahresbericht*, Bd. 14, S. 483.

W. G.

II. MINERALOGY AND GEOLOGY.

1. *Recent developments with regard to the Geology of California made by the Survey under the direction of* Prof. J. D. Whitney, State Geologist. (Communicated by Prof. Whitney in a letter to Prof. W. H. Brewer, dated San Francisco, Jan. 19, 1866.)—During the past summer, Mr. Remond has traced the belt of Jurassic rocks, first discovered on the Mariposa Estate, as far as the Stanislaus River, finding fossils at several localities, the *Ancella Errington*i being the most abundant, although several new species of other genera have been found. It is probable that we shall be able to follow this belt entirely through the Sierra Nevada in the course of our detailed explorations.

The results of Mr. Remond's work in Mexico during the past two years are quite interesting, and will be prepared by him for publication. A synopsis of his principal results will soon be forwarded to the Journal of Science. As one of the most striking facts, may be mentioned his

discovery of plants in connection with the valuable beds of anthracite in Sonora. These plants have been examined by Dr. Newberry and are referred by him to the Triassic epoch.

I am pained to have to add that the state of Mr. Remond's health has obliged him to resign his position in our Survey, and that he is about to leave for Chili, where, however, his acquaintance with the rocks and fossils of California cannot fail to stand him in good stead, and if his health allows it, he will, no doubt, be able to add much to our rather scanty stock of information in regard to the geology and mining interests of that extremely interesting country.

Messrs. King and Gardner have been temporarily detached from our Survey and have gone to Arizona, in company with Mr. C. A. Brinley, an amateur photographic artist. These gentlemen have been enrolled in the service of the United States as assistants to the Engineer corps, and are attached to Gen. Mason's staff. They are well furnished with instruments for astronomical and topographical work, and will in all probability have an excellent opportunity to add to our knowledge of the geography and geology of a region which is now attracting much attention, and in regard to which we stand much in need of more light.

Mr. Gabb has been engaged for some time past in working up the invertebrate fossils of the Tertiary rocks of California. The first portion of his work, containing descriptions of about fifty new species, has gone to the printer. It will form the beginning of volume II of the Paleontology of California. The plates, thirteen in number, will also be engraved as soon as possible, having been all drawn. A considerable number of new Cretaceous fossils have been collected by the members of the Survey and others, and a portion of them have been drawn. Mr. Gabb is now engaged in exploring some portion of the Coast Ranges south of the Bay of Monterey which have not yet been visited by any of our corps. This duty will probably occupy him for the next four or five months.

The collection of fossils recently brought to our office from the State of Nevada have added considerably to our knowledge of the geology of the region east of the Sierra. The astonishing development of the Upper Trias in Nevada becomes more and more evident, and it is indeed remarkable that such immense outcrops of highly fossiliferous rocks, extending over so vast an area, should have remained unknown so long, although the country has been so often traversed by exploring parties. We have received from Mr. Blatchley fine specimens of some of the most characteristic species of the Trias of the Humboldt Ranges, and which come from as far east as lon. 117°. Triassic fossils have also been found 150 miles south of Unionville and nearly in the same longitude as the most western Humboldt range. I feel confident that we shall be able to obtain very important additions to our stock of knowledge with regard to the geology of the Great Basin during the coming season, and shall make arrangements to have work done there at some points which promise very interesting results.

The statement made in the newspapers and copied into the Journal of Science, that Mr. R. H. Stretch had been appointed State Geologist of Nevada, is not correct. The requirements of the Legislature that a sur-

vey of the State should be made in eight months on an appropriation of $6000, was so manifestly absurd, that the governor declined to make any appointment.

As soon as the Legislature has acted in reference to the continuance of the Survey, I shall take pleasure in communicating our plans for the prosecution of the work during the coming season.

2. *On Native Lead from the Northwest shore of Lake Superior;* by Prof. E. J. CHAPMAN, of Toronto.—As a natural product, lead is well-known to be of exceedingly rare occurrence in the simple or metallic state. On this continent—apart from its occurrence in the meteoric iron of Tarapaca, in Chili—it has hitherto been noticed only at one spot, namely: in a galena vein, traversing limestone (of unstated geological age), near Zomelahuacan, in the Province of Vera Cruz, in Central Mexico. The specimen, from the locality now under consideration, was obtained by Mr. McIntyre, of Fort William, at a spot near the celebrated Dog Lake of the Kaministiquia. The lead occurs in this specimen—the only one, I believe, discovered—in the form of a small string in white semi-opaque quartz. The quartz, which constitutes a narrow vein, does not appear to contain the slightest speck of galena, or of any other substance, except a small quantity of specular iron ore; and the unaltered appearance of the latter is such as to preclude the supposition of the lead having been derived from galena, or other lead compound, by artificial heat. Before coming to my hands, the specimen had been examined by Mr. T. W. Herrick, whose extensive surveys and explorations in this region are so well known, and by him it was looked upon as metallic lead. My experiments fully confirm this determination. The lead, when cut, presents the ordinary color, softness, and ductility of the pure metal. The specific gravity cannot be properly taken, on account of the very small quantity at command, the larger portion of the lead having been used up before the specimen came into my possession. Tested by the blowpipe, however, the substance melts readily, and volatilizes; imparting a blue tint to the flame-border, and forming a yellow ring of oxyd on the charcoal. The fused globule is perfectly malleable. On the cupel, it becomes entirely oxydized and absorbed, without leaving a trace of silver. The cupel-stain, when cold, is of a clear yellow color, showing the absence of copper, nickel, &c. The nitric acid solution yields with reagents the ordinary reactions of lead-oxyd. The substance is distinguished from galena by its ductility, and by yielding no sulphur-reaction with carbonate of soda before the blowpipe. From bismuth, also, it is distinguished by its perfect malleability, as well as by the blue color which it imparts to the outer border of the blowpipe flame. As a further test, it may be stated that a small cutting, placed in a solution of bismuth in nitric acid, produces a black arborescent precipitate of that metal.

This discovery is interesting, not only from the extreme rarity of *Native Lead*, but from the fact, also, that in the few undoubted European localities in which the metal has been found, the latter is generally accompanied by gold. The quartz in which the Lake Superior specimen occurs has, curiously enough, the somewhat waxy aspect and other characters, more easily recognized than described, of the gold-bearing quartz of California and other auriferous districts; and the geological position of the bounding rock, immediately above that of the Huronian strata, is

in a measure identical with the horizon of the gold-bearing rocks from which the auriferous deposits of Eastern Canada have been derived. No gold has hitherto been met with, however, in the sands of the Kaministiquia or other streams of Thunder Bay.—*Canadian Journal for Nov.*, 1865.

3. *Notes on Wisconsin Drift;* by J. S. Bliss. (Communication, dated Door Creek, Dec. 4, 1864.)—Recently I took occasion to examine in Lowell, Dodge Co., Wisconsin (lat. 43° 18′, long. 88° 51½′), some large boulders taken from hills or ridges, and in part from only slight elevations above the common level, and I found in them positive evidences of the drift movement. One was rough, for instance, on one side of the more elevated part of the stone, while on the other, it was quite well *smoothed* and *grooved*, the grooves running rather obliquely across. The smooth side was very nearly flat. Another, found in the same excavation, exhibited these traces of grooving and polishing in the central portion, their course being that of the longest diameter of the boulder. Either of them may perhaps weigh a ton.

Still another feature is seen twenty-five miles from the former place, in which the limestone in a railroad excavation, lying between two low tracts of low land, is only covered by perhaps five or six feet of recent deposits, and where this is left bare, owing to the denuding action of the rains, is plainly to be seen the same smoothing and grooving. On both sides, the grooves are exactly in *line*, although the rock is removed four feet below the surface of the lime rock. The polishing is in the direction *southwest by south*. These low tracts have undoubtedly been filled up, having once been very much deeper on either side of the flat rock—a rock that was once the summit of quite a high elevation, and which must have been acted upon similar to the high hills and mountains of New England.

There is still another fact which I will mention. On a recent visit to the Chicago lake tunnel, I saw small boulders which were taken four thousand one hundred and thirty-seven feet (4,137) from the mouth of the tunnel, with the same markings, the grooving being the more prominent feature. Small pieces of copper-bearing stone, like that of Lake Superior, is also found there. It appears, therefore, that small boulders found far down beneath the bed of Lake Michigan bear the same marks as those obtained in our Wisconsin hills.

4. *On Borax in California;* by Prof. J. D. Whitney.—Some explorations have been made around the lower end of Clear Lake, more particularly for the purpose of getting an idea of the very interesting locality of borax, which is found in this region.

Clear Lake is about sixty-five miles northwest of Suisun Bay, and about thirty-six miles from the Pacific. It is believed to be about twenty-five miles long, but has never been surveyed, so that its shape and size are not accurately known. * * *

At the angle where the narrow part of the lake opens out to the west is a high mountain, which comes down with a precipitous front to the water, and which is supposed to be about 2500 feet above the lake-level. It is called the "Uncle Sam Mountain," and, as seen from the opposite side of the lake, it appears to be made up of a closely folded synclinal mass, probably of somewhat metamorphic Cretaceous sandstones. On the southwest side, and to the southeast, volcanic materials and rocks oc-

cupy the surface, as is well seen in a crater-like depression on the southwest side of the narrow arm of the lake, called "Thurston's Lake," which is partly covered by water, and surrounded on all sides by high cliffs of volcanic rocks, appearing as if it might have been one of the vents from which the eruptive matter, obsidian, ashes and pumice, so abundant in this region, were ejected. On the eastern side of the narrow arm of Clear Lake, nearly opposite to, and about four miles distant from, Thurston's Lake, is a large accumulation of volcanic materials, with much obsidian and pumice. In fact, all through the chain of the Coast Ranges in this direction, down Grizzly Cañon to Bear Valley, on the trail to Colusi, there are hot springs and the remains of Solfatara action, indicating strongly a cross-fracture in this region, through which the volcanic agencies have made themselves perceptible, and which probably connects on the southwest with the Geysers, thus forming a line of volcanic action nearly if not quite across the chain.

Among the evidences of the former working of volcanic forces in this region, there is nothing more interesting and remarkable than the so-called "Borax Lake" and its vicinity. This lake occupies a depression on the east side of the narrow arm of Clear Lake, from which it is separated by a low ridge of volcanic materials, lying loosely heaped together, and consisting of scoriæ, obsidian, and pumice. The Borax Lake is of variable dimensions, according to the season of the year and the comparative dryness of the season. When examined (September, 1863), the water occupied an area about 4000 feet long, and 1800 feet wide in the widest place, and its shape was irregularly oval, its longer axis being turned in the direction of east and west, magnetic; it has once extended nearly twice as far to the southeast, as the ground is hardly raised above its present level in that direction for nearly a mile. The lake is said to have been entirely dry during the summer before the great rains of 1861–62. In 1863 the water was about three feet deep.

The existence of this lake was first made known to the world by Dr. J. A. Veatch, who examined it in September, 1856, and detected the presence of borax in its waters; but it was not until some months afterwards that the existence of a large bed of crystals of this valuable material in the bottom of the lake was discovered. The land about here has been located by the "California Borax Company," the agents of which have caused explorations to be made, have had the waters carefully analyzed, and were, in 1864, preparing to manufacture borax on a large scale.

The water collected from the Borax Lake, in September, 1863, as analyzed by G. E. Moore, contained 2401·56 grains of solid matter to the gallon, of which about one-half was common salt, one-quarter carbonate of soda, and the remainder chiefly borate of soda, there being 281·48 grains of the anhydrous biborate, equal to 535·08 of crystallized borax to the gallon. Traces of iodids and bromids were also detected. A sample of water taken from the interior of a coffer-dam sunk in the middle of the lake, and which had been allowed to fill by percolation from the bottom upward, was found to be more concentrated, yielding 3573·46 grains of solid matter to the gallon; but it contained nearly the same ingredients, and in the same proportions, as the water of the lake itself. The borax, being the least soluble substance contained in

any notable quantity in the water, has in process of time crystallized out to a considerable extent, and now exists in the bottom of the lake in the form of distinct crystals, which are of all sizes, from microscopic dimensions up to two or three inches across. These crystals form a layer immediately under the water, intermixed with blue mud, of varying thickness; as observed in the coffer-dam sunk in 1863, the layer of crystals was about eighteen inches thick, and beneath it was mud without crystals. The thickness, however, of the deposit is undoubtedly very variable, and there are, in places, several layers of them separated by beds of clay or mud. It is believed, by those who have examined the bottom of the lake, that several million pounds of borax may be obtained from it by means of movable coffer-dams, at a moderate expense, and so as to yield a handsome profit to those engaged in the enterprise. How much of a supply of water could be obtained by boring, and what its quality would be, can hardly be settled in any other way than by actual experiment.

Lying about a mile beyond the ridge which borders the Borax Lake on the northeast, and at the foot of a shorter arm of Clear Lake which extends off to the southeast parallel with the longer one, is an interesting locality where solfatara action is still going on, and where a large amount of sulphur has accumulated. This is called the "Sulphur Banks." It consists of a much decomposed volcanic rock, fissured in innumerable places, through which fissures steam and gas are constantly issuing, and all over and through which large quantities of sulphur have been deposited, so as to give the mass, from a little distance, the appearance of being entirely composed of this material. Into some of these cavities a pole may be inserted for several feet, and they are often lined with fine crystallizations and stalactites of sulphur. No doubt a large quantity of this material could be obtained here, and the time will probably come when it will be made available. It is the largest deposit which we have seen in the State, covering several acres of ground; but to ascertain its value and determine the quantity of pure sulphur it contains, it would have to be dug into at various points.

Near the sulphur bank, just at the edge of the lake, is a hot spring, of which the outlet is, even at low water, partly beneath the lake, so that the amount which flows from it cannot be ascertained without some expenditure, to keep out the surrounding water. The flow of this spring seems to be quite variable at different seasons, and probably the amount of materials it holds in solution is far from constant. Dr. Veatch found the area over which hot water was percolating through the sand to be 150 by 75 feet in dimensions; at the time of our visit it was much less; nor was the estimated yield anything like as great as he made it, namely, three hundred gallons per minute.

The water of this spring, as analyzed by Mr. Moore, is found to be of a remarkable character; his analysis is subjoined.

	Grains in one gallon.
Chlorid of potassium,	trace.
Chlorid of sodium,	84·62
Iodid of magnesium,	·09
Bromid of magnesium,	trace.
Bicarbonate of soda,	76·96

Bicarbonate of ammonia,	107·76
Biborate of soda,	103·29
Sulphate of lime,	trace.
Alumina,	1·26
Carbonic acid (free),	36·37
Silicic acid,	8·23
Matters volatile at a red heat,	65·77
	484·35

In this table the constituents are necessarily calculated as anhydrous salts; the biborate of soda, however, contains about 47 per cent of water when crystallized, and the 103·29 grains given above, correspond to 195·35 of crystallized borax. The most extraordinary feature in the above analysis is the very large amount of ammoniacal salts shown to be present in this water, in this respect exceeding any natural spring-water which has ever been analyzed. Mr. Moore thinks that, as in the case of the boracic acid waters of Tuscany, this ammoniacal salt may be separated and made available for economical purposes. This locality is worthy of a most careful examination to ascertain how considerable a flow of water can be depended on.—*From Prof. J. D. Whitney's Geological Survey of California*, vol. i, p. 96.

Additional note.—The San Francisco papers received last Saturday state, in regard to the California borax: During the year they have supplied the local demand of thirty to forty tons and shipped two hundred tons to New York. The borax is collected from the mud at the bottom of the lake, during the dry season, the yield last season averaging about two and a half tons per day. The "crude borax" thus obtained is "so pure that the Mint and assayers of the city use the crude article in preference to the refined brought from abroad."—*Weekly Bulletin, Jan.* 13th.

5. *Gigantic Marsupials of Victoria, Australia.*—A very interesting addition to the National Museum collection of Melbourne, has recently been made through the kind offices of Dr. Greeves, who has on former occasions greatly enriched the museum with fossil bones. The present addition is a small series of four specimens found at Murchill Station (belonging to Mr. John Bell), presented by Mr. Charles Dyson, of Market Square, Geelong, through Dr. Greeves, and giving evidence of two gigantic animals of great rarity in Victoria, and of which the national collection had hitherto no examples. The largest specimen is a fragment of the posterior part of the left ramus of the lower jaw, with the last molar tooth, of the *Nototherium Mitchelli*, an extinct gigantic marsupial herbivorous animal, as big as a bullock in the body, intermediate between the kangaroo and native bear in affinities, not hitherto known to occur in Victoria. Immediately with this specimen were two great canine teeth about the size of those of a tiger, and nearly the same shape of root, which is coarsely sulcated longitudinally, the conical crown being worn down obliquely by use like those of a very old Tasmanian species (*Sarcophilus ursinus*), specimens of which can be seen in the case on the left hand of the entrance to the gallery in the National Museum building at the rear of the university. These teeth are of the highest possible interest to the Australian geologist and zoologist, as they are the first remains of this part of the extinct gigantic carnivorous marsupial, the *Thylacoleo*

carnifex, which have ever been found, and they help to prove the truth of Prof. Owen's suggestion, that at the time when the gigantic *Diprotodons* lived in Australia there was a powerful carnivore large enough to tear them in pieces, and prevent their undue increase, most nearly related in savage disposition and general structure to the Tasmanian species above referred to, but about a third larger than the largest living lion.—*Reader*, *Oct.* 28, from the *Melbourne Argus.*

6. *On Phosphatic Deposits recently discovered in North Wales;* by Dr. Aug. Voelcker.—An extensive mine, containing several phosphatic minerals, was accidentally discovered early last year by Mr. Hope Jones, of Hooton, Cheshire, whilst he was searching for other minerals in the neighborhood of Cwmgynen, about sixteen miles from Oswestry. Mr. Hope Jones found the phosphatic mine to be continuous for more than a mile, and to come within twelve feet of the surface. It is not far from the clay slate and lead-bearing district of Llangrynag. The strata (slaty shale) contain several beds of contemporaneous feldspathic ash and scoriæ, and the usual fossils of the Llandeilo series are found, but not in great numbers. The strata are vertical, and run east to west, or, more correctly speaking, fifteen degrees north of west (magnetic).

A true vein, or fissure containing vein deposit, partially metallic, divides two phosphatic deposits. One of them is nearly three yards in thickness, and embodies phosphatic limestone beds, containing from ten to upwards of thirty-five per-cent of phosphate of lime. The other, and more valuable deposit is a yard and a-half thick, and consists of a black, graphitic shale, largely impregnated with phosphate of lime. This deposit is free from carbonate of lime, and much richer in phosphate of lime than the first-mentioned deposit. In specimens taken at a depth of about twelve feet from the surface, Dr. Voelcker found from 54 to 56 per cent of phosphate of lime in this phosphatic shale. At a greater depth the shale becomes richer in phosphates, and, consequently, more valuable. In the deeper specimens the proportion of phosphate of lime amounted to 64½ per cent. This phosphatic mine is readily accessible, and naturally drainable to a depth of about 500 yards (?), and contains many hundred thousand, if not millions, of tons of valuable phosphatic minerals. The discovery of this extensive mine in England appears to be of great importance to the English agriculturalist, who at the present time consumes annually many tons of phosphatic minerals in the shape of superphosphate and similar artificial manures.—*Proc. Brit. Assoc.*, *Reader*, Oct. 21.

7. *Observations on Certain Drifts and Ancient River Beds of Siluria and South Wales*; by Mr. Symonds.—The nearly total submergence of Siluria and Wales during the marine glacial period the author considered as proved by the position of marine shell-bearing drifts, containing large ice-worn erratics, upon mountain platforms in North Wales. These drifts have been found in several localities at the height of nearly 2,000 feet above the sea. The conclusions arrived at by Sir Charles Lyell, Professor Ramsay, and others, are well known, and they all tend to prove that large portions of Wales and Siluria were submerged during a period of the glacial epoch, which may be denominated as the *glacial marine* period. If this was the history as regards North Wales, Mr.

Symonds contended that it applies also to South Wales, almost the whole of which he believes to have been submerged during this glacial marine period. Accompanied by his friend, the Rev. Jas. Hughes, he had crossed the hill of Craig Turch this summer, where the river Cothi rises, half-way between Llandovery and Tregarron, among the wildest scenery of South Wales. Here he observed large erratic rocks resting on drift similar in position to those of the Maenbras below Snowdon; and he believed these erratics to have been transported from afar by ice-rafts floating over a glacial sea. The hill platform of Craig Turch, like that of Moel Tryfaen, and the Snowdon country, had been elevated in the course of ages to its present height. In the accumulation of the marine drifts of the Snowdon country there could be no doubt about their origin, for they contain numerous sea-shells, and many striated, polished, erratic blocks, which must have been dropped into them by floating ice. The author thinks some of the more elevated mountain platform drifts of South Wales must be attributed to the same origin—viz., a glacial marine origin.

But, while believing that there are unmistakable proofs throughout Siluria of long periods of submergence and of gradual elevation, as proved by the position of marine boulder-bearing drifts at different elevations, the author maintained that the effects of land-ice and snow in transporting great masses of local rocks to long distances had not been sufficiently observed. He always suspected the ice-raft or iceberg theory when applied to the transportation of any erratic which he did not see covered up and lying in stratified marine deposits of sand and gravel, like those on Moel Tryfaen. He had observed immense deposits of transported rocks so peculiarly local that it seemed impossible to suppose they could have been left by icebergs or rafts. No geologist could explore the valleys of the Wye, Severn, Usk, Towy, Tivy, Cothi, Rheidol, Yswith, Teme, and Lugg, without observing that the heads of those valleys were at one time filled with unstratified boulder clay or till, and that through this till the rivers have excavated their channels. This till is entirely unlike the stratified boulder-bearing silts of marine origin. The boulders contained in this till are all local, are frequently elevated above all signs of even the most ancient river action, have never been acted upon by water action of any kind, and, though belonging to rocks *in situ* in the district, have been carried across particular districts and down particular hills; while as regards the erratics borne by icebergs they are mingled and heterogeneous. On many hills in Wales you observe boulders of entirely local origin studding hill sides and resting on rocks to which they do not belong, but they have a local distribution, and have been derived from a local center. He had observed also that in numerous instances the transported rocks never crossed a valley, as in the case of Dean Forest, where masses of millstone grit and mountain limestone are found on one side of the valley, but not one can be found on the hills across the Wye. If these boulders had been moved by iceberg agency it was impossible to understand how the ice rafts moved so peculiarly as always to adapt themselves to the rocks *in situ* on the hills, and did not sometimes depart from one direction and strand large masses somewhere out of the line of the existing valleys and the lines of the hill slopes. The

whole tendency of Mr. Symonds's paper was to show that since the elevation of the land into its present condition glacial phenomena were continued long after that elevation, and that although there are evidences of marine glacial action, those evidences have been much obliterated and destroyed by the long-continued and later effect of land-ice and snow. He attributed the transportation of the masses of subangular gravel, which contains large erratics from the Malvern range, and are distributed in patches on the Hanley and Castle Morton plains, to the effect of a mass of frozen snow and ice which in former days stretched from the Malverns down to the plains. The ancient river terraces of Siluria are well marked, and stand out in some instances at a height of 1,000 feet above the existing river channels. In Worcestershire it is difficult to make out where the marine conditions ended and the river conditions commenced. The section at Pull Court, opened up by the funds of the Malvern Field Club, he thought contained subfossil marine shells. These evidences broke down under the investigations of Mr. Gwynn Jeffreys. The specimens were all worn secondary fossils; so whether those high-level drifts were marine or freshwater remains yet to be proved.—*Ibid.*

8. *The Buckler-head Fish.*—Mr. Ray Lankester, of Downing College, Cambridge, read a paper "On the British Species of Cephalaspis and the Scotch Pteraspis." He stated that he had acquired a very large mass of evidence by the assistance of various friends, particularly Mr. Powrie, the laird of Reswollie, Forfarshire. From these specimens he was able to determine that there were only four British species of Cephalaspis, and they were *C. Lyellii*, of Agassiz, confined to Scotland and perhaps the passage-beds of Herefordshire (*C. ornatus*); *C. Murchisoni*, of Egerton, that common in the cornstones, which was a distinct and unnamed species; *C. Asterolepis*, of Dr. Harley, a well-marked form, found in the cornstones; and *C. Salweyi*, of Egerton, also very well characterized.—*Ibid.*

9. *On the occurrence of an internal convoluted plate within the body of certain species of Crinoidea;* by James Hall.—During the investigations upon the Crinoidea of the Carboniferous Limestones of Iowa, there were discovered in the broken bodies of several species, a vertical convoluted plate, filling a large part of the cavity of the body. At that time I showed several of these specimens to Prof. Agassiz, who informed me that he had observed a similar convoluted plate in the body of Comatula.

This convoluted intestinal plate was first observed in the body of *Actinocrinus pentagonus*, and afterwards in *Actinocrinus longirostris*, *Act. erodus*, *Act. Verneuili*, and in a species of the type of *Act. umbrosus*. In several of the specimens, and this is apparently true of all the Actinocrini, the opening into this convoluted sac is wider at the apex, and becomes gradually attenuated below and pointed toward the center of the basal plates where it is attached. The lower portion is twisted not unlike the lower portion of some univalve shells, and this organ, in one specimen, presents a very close resemblance to a small Bulla or similar shell. In *Actinocrinus longirostris* this organ is proportionately very large, the sides straighter and less curved, and very wide at the top.—*Proc. B. S. N. H.*, x, 33.

10. *Researches in the Lingula Flags in South Wales;* a joint report by Mr. H. Hicks and Mr. J. W. Salter.—The results of these researches have led to the discovery of an entirely new British formation, and the authors propose a new term for the group. The district of St. David's was anciently called "Minevia," and hence, following the example of the best geologists—viz., first to ascertain the position, then the fossil contents of a group, and then to name it—the authors propose the term "Minevian" for the lowest division of the "Lingula flags." Mr. Hicks described five sections north and south of St. David's—the coast affording admirable views of all the beds, from the central syenite through the olive, grey, green, and purple beds of the Lower Cambrians, into the light grey, black, and grey shales of the Minevian group. Some of the sections show a passage from this group into the Ffestiniog group of Professor Sedgwick, which forms the main mass of the "Lingula flags proper," and in Whitesand Bay these are again overlaid by the Skiddaw group and the Llandeilo flags. Each of the sections has shown fossil traces after a long and persevering search. But the section at Porth Rhaw is not only the typical one, but contains all the principal fossil types—trilobites of six or seven genera, and about fifteen species; Brachiopod and Pteropod shells, Cystideæ, and sponges of two or three different kinds. All of them are distinct not only as to species, but usually as to genera also, from the overlying rocks of the true "Lingula flags." And as the history of discovery in the Paleozoic rocks has always been that every group beneath the Old Red Sandstone containing a distinct fauna has received a separate name, the authors hold it of prime importance not to confound this fauna with that of any of the overlying rocks of the Silurian or even Upper Cambrian systems. If Llandeilo, Caradoc, Llandovery, and Wenlock imply distinct periods of creation, much more does the term "Lingula flag" and "Ffestiniog group" indicate a more remote period, in which not even the genera of fossil animals common in the great Silurian deposits are to be found. All is distinct and anterior, lower in point of organization, more limited in point of numbers; the species even, with some exceptions, diminishing in size. We seem to be coming to the zero of animal and vegetable life. As indicative of the value of a close observation of these old faunæ, it may be sufficient to say that by means of this Minevian group we can tell the true horizon of the gold-bearing rocks of Wales; we can identify accurately the oldest fossil-bearing strata of Bohemia and Sweden with those of our own country; and assign them their exact position in the Palæozoic series. The genus *Paradoxides* becomes in this way one of the medals of creation, and the index of a most remote age—so remote, that only a few, and those the humbler members of the invertebrate classes, inhabited the sea before the cuttlefish or the nautilus was created, as these last were long anterior to the very earliest of the fishes. With regard to the distribution of the fossils themselves, the lowest beds, which actually lie among the uppermost coarse beds of the Cambrian grits, only distinguished from them by the want of purple color, contain a species of *Paradoxides* (*P. Aurora*), with which are associated some minute Trilobites, *Agnostus*, *Microdiscus*, &c. Farther up we have *Paradoxides* again, but of a distinct species and larger. The mass of the

fossils then come in, both crustaceans, shells, and sponges; and high up in the series a third *Paradoxides*, so large as to attract general notice—the well-known *P. Davidis*. Specimens of each of them were exhibited on the reporters' table. Mr. Hicks described beds of contemporaneous trap, such as had been previously noticed by his colleague, but also showed their origin and direction; and the faults of the region were touched upon, but could not be fully described. The district is evidently a prolific one, containing a new and most interesting formation; and as St. David's cathedral is now being restored, and as there is an excellent bathing strand close by, it is likely that this remote corner of the island will attract both geologists and non-scientific visitors. The time allotted to the authors was so short, and the President's mandate so urgent, that scarcely even the general facts of the communication could be touched upon.—*Proc. Brit. Assoc., Reader, Nov.* 11.

III. BOTANY AND ZOOLOGY.

1. *Botanical Necrology for* 1864 *and* 1865.—Following a chronological order we have first to mention a botanist whose decease, although occurring in the year 1862, has only recently been known to the world of science:—

Dr. Christian Friederich Lessing,—the author, in 1832, of the classical *Synopsis Generum Compositarum*, in honor of whom and his celebrated grandfather, Gotthold Ephraim Lessing, Chamiso named the little Californian Aster-like *Lessingia Germanorum*—had entirely disappeared from view for the last thirty years. About that time he went to Siberia, with a view to botanical explorations; but engaged in mining speculations, practiced medicine, and finally became a brewer, with ill fortune in all his undertakings, as it appears. These facts seem to have come to light only since his death, which, as stated by von Schlechtendal in the Botanische Zeitung, took place in the year 1862, at Krasnojarsk, a village on the Jenisei, between Tomk and Irkutsk.

Nicolaus Turczaninow, one of the oldest Russian botanists, author of many botanical papers, and of a *Flora Baicalensi-Dahurica*, died at Charkow, in January, 1864. He had suffered, during the last years of his life, by a fall from a ladder in his herbarium. Several years ago his large herbarium was made over to the University of Charkow.

Hermann Crüger, at the age of 45, died Feb. 28, 1864, in San Fernando, Trinidad, where he was the Superintendent of the Government Botanic Garden. He was the author of several interesting papers in the Botanische Zeitung upon vegetable anatomy and morphology; and he had taken up the subject of the fertilization of Orchids by the aid of insects,—a subject on which much was to be expected from his ability and excellent opportunities. A short paper of his, containing his observations on *Catasetum*, *Stanhopea*, &c., communicated to Mr. Darwin, was published, after his death, in the 31st No. of the Journal of the Linnæan Society.

Francis William Junghuhn, a botanist who in former years made considerable collections in the Dutch East Indies, and who returned to Java a few years ago to take charge of a government garden, died at Lembang, on the 24th of April, 1864, aged 52 years.

Ludolf Christian Treviranus, Professor of Botany in Bonn University, the Nestor of botanical professors, and one of the very oldest botanists in Germany, died at Poppelsdorf, May 6, 1864. His age is not mentioned. But the earliest of his numerous works recorded by Pritzel (the best of which are physiological) was published in the year 1806. The latest of any extent was his elaboration of the genus *Carex* for Ledebour's Flora Rossica.

Dr. Hermann Schacht, a distinguished vegetable anatomist and physiologist, and author of several well known works, formerly an assistant of Schleiden at Jena, was appointed to the chair at Bonn vacated by the death of Treviranus. His health, however, had of late years been much impaired; and he had barely entered upon the duties of his honorable position when, on the 20th of August, 1864, he died, at Poppelsdorf, at the age of 50.

Adolf Scheele, pastor at Heersum, near Hildesheim, author of several papers in the Linnæa, died Sept. 7, 1864, in the 57th year of his age. He appears to have been a botanist of considerable merit; which, however, was not greatly shown in his contributions to the Flora of Texas, based upon a portion of Lindheimer's plants and upon a collection made by his friend Prof. Römer, who placed them in his hands.

Johannes Wilhelm Sturm, a name distinguished in German botany for two or three generations, died January 7, 1865, in the 57th year of his age. His latest work was his elaboration of the *Hymenophylleæ* for Martius's *Flora Brasiliensis*.

Dr. Hugh Falconer, who wrote upon botany as well as upon zoology and paleontology, and made very extensive and excellent botanical collections in Upper India (which were mostly destroyed by dampness and neglect in the cellars of the East India House), died in London, January 31, 1865, aged 57 years. Obituary notices of this distinguished naturalist have already appeared in this Journal.

Sir Robert Hermann Schomburgk, who did much for botany in his exploration of British Guiana about 30 years ago, and by whose agency somewhat later the *Victoria regia* was made known and introduced into England, died at Berlin, on the 11th of March, in the 61st year of his age.

Dr. Heinrich Schott, for many years director of the Imperial Gardens at Schönbrunn, died there on the 5th of February, 1865, at the age of 71 years. Although he had written upon Ferns and other departments of botany, his scientific fame rests chiefly upon his works upon the *Aroideæ*. He was the highest authority upon this difficult order, which he had completely mastered. A notice of his principal publications will be found in the third volume of the present series of this Journal.

Sir Joseph Paxton, whose decease, on the 5th of June last, in the 62nd year of his age, has already been recorded in this Journal (xl, p. 140), must also be reckoned among the botanists, having for many years edited the Magazine of Botany, Paxton's Flower Garden, and other popular works. He was an eminent horticulturist, and, after constructing the great glass and iron conservatory at Chatsworth and furnishing the design for the celebrated Crystal Palace in Hyde Park, he removed to Sydenham, and became a distinguished architect and civil engineer.

Sir John Richardson, the well-known Arctic explorer, zoologist and botanist, died on the 5th of June last, in the 78th year of his age. He was born at Dumfries, Scotland, Nov. 5, 1787, completed his medical education at Edinburgh, and entered the navy as assistant surgeon. When he retired, at the beginning of the war in the Crimea, he was, we believe, the senior officer in the medical service, and had held for many years the honorable post of inspector in charge of Haslar hospital. It was while in this position that Richardson, already advanced in years, at his own request, conducted the last overland search for his old friend and companion in earlier Arctic perils, Sir John Franklin. His labors and hardships in these explorations, and the valuable works which he produced upon the geography, climate, and natural history of Arctic America need not be here enumerated. The work by which his name is indelibly associated with American botany is his botanical appendix to Franklin's first overland journey, published in 1823, the most important essay of the time upon Arctic plants, and the precursor of Hooker's Flora of British America.

Hugh Cuming, the renowned collector in natural history, especially of shells, and whose botanical collections in Chili, the Pacific Islands, the Philippines, &c.,—distributed in sets fifteen or twenty years ago, were very extensive,—died in London, on the 10th of August last, at the age of 74 years.

Thomas Bridges, who, as well as Mr. Cuming, made extensive botanical collections in Chili, Bolivia and Peru, beginning more than thirty years ago, but who has for the past eight or ten years resided in California and British Columbia, died on the 9th of November last, on his return to California, from an expedition to Nicaragua.

Sir William Jackson Hooker, as our readers well know, died on the 12th of August last, at the age of 80 years. A biographical notice of this eminent botanist forms the leading article of the present volume. We are informed that the affection of the throat of which he died was not diphtheria, as we had stated.

John Lindley, one of the most renowned botanists of the age, died at his residence near London, on the 1st of November last, at the age of 66 years. A few lines of our January number contained an announcement of this sad event (p. 6, foot-note), with an incidental expression of our sense of the services he has rendered to science. We add some biographical details, compiled from the excellent notice which appeared in the Gardeners' Chronicle, the paper which Dr. Lindley[1] established and edited for a quarter of a century.

He was born at Catton, near Norwich, where his father was a nurseryman, on the 5th of February, 1799; and was educated at the Norwich Grammar School, as was his friend and earliest scientific acquaintance, Sir Wm. Hooker. It was at the house of the latter, soon after his removal to Halesworth, that young Lindley began his career of authorship by translating Richard's *Analyse du Fruit*, which was published in 1819. He appears already to have devoted himself to botanical and horticul-

[1] Mr. Lindley received the degree of Doctor of Philosophy from the University of Munich, in the year 1832.

tural pursuits, and, it is said, had arranged to visit Sumatra and the Malayan Islands; but for some reason—perhaps connected with his father's reverses in business,—the project was abandoned. At this juncture, he was introduced by his friend Hooker to Sir Joseph Banks, who employed him as his assistant librarian. Sir Joseph recommended him to Mr. Cattley, for whom he edited the folio *Collectanea Botanica*, illustrating some of the new and curious plants cultivated in Mr. Cattley's collection. He had already published his Monograph of Roses (1820), and his Monograph of Digitalis (1821), the latter illustrated by plates from Ferdinand Bauer's drawings. The next year (1822) began his connection with the Horticultural Society, as Garden-Assistant Secretary, when he took charge of the laying out of the garden at Chiswick. In 1826 he became sole Assistant Secretary, Mr. Sabine being Honorary Secretary until 1830, and then Mr. Bentham until 1841; nearly the whole active charge of the establishment falling upon Dr. Lindley. Then, as Vice Secretary he conducted the operations of this great and most prosperous society, with almost undivided responsibility until 1858, when, dropping the laboring oar, he became Secretary and Member of the Council, and took a leading part in the reorganization of the society, until, fairly broken down by overwork, in 1862 he was obliged to retire from the management. Besides his work in the Horticultural Society, sufficient of itself to task any ordinary powers, Dr. Lindley was Professor of Botany in University College from 1829 to 1861, giving elaborate courses of lectures every year, and also Lecturer at the Apothecaries Garden at Chelsea for nearly the same period. He conducted the Botanical Register from about 1823 (although his name does not appear upon the title-page until somewhat later) down to its close in 1847; he did the principal botanical work in Loudon's Encyclopedia of Plants, and wrote the botanical articles for the Penny Cyclopedia, down to the letter R; contributed to the Transactions and Proceedings of the Horticultural Society, and edited its Journal; prepared the later volumes of Sibthorp's magnificent *Flora Græca*, &c., &c.,—besides writing and often re-editing his numerous classical botanical works, which, with his lectures to successive classes of pupils inspired by his own ardor, have made his name so famous wherever botany is cultivated. Of these numerous works we can mention only the principal. His Synopsis of the British Flora arranged according to the Natural Orders, first issued in 1829, has only a local and historical interest, as a part of his successful endeavors to introduce and popularize the natural system in England, where it had peculiar obstacles to contend against. His Genera and Species of Orchidaceous Plants, with his *Sertum Orchidaceum* and, later, his *Folia Orchidacea* (which he was able only to commence), embody a portion of his labors upon an important and curious family of plants, upon which he became the paramount authority. His Introduction to Botany, which ran through four editions, his Outlines of the First Principles of Botany, at length expanded into his Elements of Botany, and his School Botany, from a series of introductory works which have done much more for botanical instruction than any others in the English language. By his *Flora Medica* he supplied to medical students a good botanical account of all the more important plants used in medicine. By his Theory of Horticulture, explaining the principal operations

of gardening upon physiological principles, in connection with his articles upon the subject in the Gardeners' Chronicle, he may almost be said to have raised this branch of knowledge "from the condition of an empirical art to that of a developed science." And, finally, in his Introduction to the Natural System of Botany, the first edition of which, published in 1830, was the earliest systematic exposition of the natural system in the English language, or fairly available to English and American students, and his further development of this work into his classical Vegetable Kingdom,—the one book which may take the place of a botanical library,—Dr. Lindley made his most important contributions to the advancement of systematic botany. The coming generation of botanists cannot be expected to appreciate the vast influence exerted by the earlier of these works in its day; the latter, however open to adverse criticism in particulars, is still unrivalled and is probably "that by which his name will be best known to posterity." Physiologist, morphologist, and systematist, he displayed equal genius in all these departments of the science, but he worked too rapidly to do himself full justice in any of them. "His power of work was, indeed astonishing; whatever he undertook [and his undertakings were wonderful in amount and variety] he did with the utmost conscientiousness, never flagging until he had done it; and he was a splendid example of what can be accomplished by a man of strong will, habitually acting up to his oft-repeated saying, that to method, zeal, and perseverance nothing is impossible." "Until he had passed 50 years of age," it is stated, that "he never knew what it was to feel tired either in body or mind." Such persons are sure to be overtasked. The Great Exhibition of 1851, adding protracted and onerous duties to his ordinary work, prostrated him with serious illness; the second Exhibition, in 1862, in which he took charge of the whole colonial department, fatally injured his bodily and mental powers, and cut short his scientific career. He was able, however, to enjoy the society of his immediate friends and to keep up an interest in his favorite pursuits quite to the close, which occurred from an apoplectic attack, on the morning of the first of November last.

Dr. Lindley was a man of marked character. While his biographer declares that "he was hot in temper and impatient of opposition," he no less truly adds that, "on the other hand, he had the warmest of hearts and the most generous of dispositions." He seemed as incapable of cherishing a resentment, as of repressing the expression of indignation for what he thought wrong; and if at times he made enemies, he was almost sure in time to convert his enemies into friends.

Dr. John Leonard Riddell, the only American botanist of this list, died in New Orleans,—where he had resided for the last thirty years,—on the 7th of October, 1865, in the 58th year of his age. His biography, written by his friends and associates in the New Orleans Academy of Sciences, is given in the January number of this Journal, p. 141.

Dr. Jean François Camille Montagne, the venerable and distinguished Cryptogamic Botanist of Paris, we have just learned, died on the 5th of January, having nearly completed the 82d year of his age. Near the close of the last century he was a master's mate in the French Navy, was in the French expedition into Egypt, where he was transferred to the civil service. After the capitulation at Alexandria he returned to Paris,

studied medicine, became an army surgeon, remained in the service until 1830; and then, indulging a long-cherished fondness for Botany, he began the career as a Cryptogamist in which he has been so useful and eminent. A. G.

2. *Essay on the Trees and Shrubs of the Ancients; being the substance of four Lectures delivered before the University of Oxford, &c.;* by C. DAUBENY, M.D., F.R.S., Professor of Botany and Rural Economy in the University of Oxford. Oxford and London, 1865, 152 pp., 8vo.—An interesting little volume, collecting with considerable research and good judgment what is known or may be reasonably conjectured in the way of identifying the principal trees and shrubs mentioned by Greek and Roman authors, or described by Theophrastus, Dioscorides, Pliny, &c. As to these primitive naturalists, Dr. Daubeny well remarks that, in consequence of the vagueness of their descriptions he has been unable, except in the case of a few conspicuous and important species, to do more than point out with some degree of probability, the natural family or at most the genus, to which the classical designation appeared intended to apply. Moreover, unavoidable ignorance has often been turned into confusion by the mis-appropriation of classical names of plants by modern botanists, and the adoption of these without enquiry by lexicographers. At the close of the fourth lecture Prof. Daubeny alludes to, and recapitulates the points of, a paper which he read to the British Association at Bath, in 1864, in which he suggests that, irrespective of changed conditions, "each species, like every individual belonging to it, has its days numbered, and that the period assigned to its duration may be extended, indeed, by favorable, and abridged by unfavorable external conditions, but in no case can transcend certain definite limits." This view has been propounded more than once before, and under close-breeding assumes a certain probability. But the external influences to which every species is subject, and the irrepressible struggle among them will probably sufficiently account for the observed facts.

A Catalogue of the Trees and Shrubs indigenous in Greece and Italy, with their ancient Greek and Latin synonyms, is appended to the volume, and will be useful for reference. For an Oxford-University book, too many Greek names are printed with wrong accents. The Birch is said not to be a native of Greece; but we have excellent authority for saying that it is indigenous to the mountains, to Pelion, for instance. By some unaccountable oversight, the second lecture contains a circumstantial repetition of the story which some bewildered penny-a-liner contributed to the Edinburgh Review two years ago, about the Cedar of the *Jardin des Plantes* having been brought from the Holy Land by Bernard Jussieu, potted in his hat, and supplied with his own short allowance of water, &c., &c.—a story which we exposed at the time in this Journal, though thinking it hardly worth the while to give so much attention. A. G.

3. *New Fluid for preserving Natural History specimens;* by A. E. VERRILL.—In consequence of the high price of alcohol, a series of experiments were undertaken by me last year, with the view of finding a substitute for it in preserving the soft parts of animals. Among the various solutions and liquids tested were nearly all that have ever been recommended, besides many new ones. Chlorid of zinc, carbolic acid,

glycerine, chlorid of calcium, acetate of alumina, arsenious acid, Goadby's solutions, and various combinations of these and other preparations were carefully tried, and the results made comparative by placing the same kind of objects in each, at the same time. Although each of these, under certain circumstances, have more or less preservative qualities, none of them were found satisfactory, especially when the *color* and *form* of the specimen are required to be preserved as well as its structure.

As a test for the preservation of color, the larvæ of the tomato-worm (*Sphinx quadrimaculata*) was used. These larvæ are difficult of preservation with the natural form and color, nearly always turning dark brown and contracting badly in alcohol and most other preparations.

As a result of these experiments the following solutions were found highly satisfactory in all respects when properly used. By their use the larvæ and recent pupæ of the tomato-worm were preserved and still retain their delicate green colors, together with their natural form and translucent appearance, while the internal organs are fully preserved. Fishes, mollusks, various insects, worms, and leaves of plants have also been preserved with perfect success and far better than can be done with alcohol. In the case of mollusks, especially, the preparations are very beautiful, retaining the delicate semi-transparent appearance of the membranes nearly as in life, with but little contraction. Another great advantage is the extreme simplicity and cheapness of the solution.

To use this fluid I prepare first the following stock solution, which may be kept in wooden barrels, or casks, and labeled:

SOLUTION A. I.

Rock salt, ...	40 oz.
Nitre (nitrate of potassa), ...	4 oz.
Soft water, ...	1 gal.

This is the final solution in which all invertebrate animals must be preserved. A solution with double the amount of water may be kept if desirable, and called A. II. Another with three gallons of water will be A. III.

In the preliminary treatment of specimens the following solution is *temporarily* employed, and is designed to preserve the object while becoming gradually saturated with the saline matter, for in no case should the specimen be put into the full strength of solution A. I, for it would rapidly harden and contract the external parts and thus prevent access to the interior. Even with alcohol it is far better to place the object for a time in weak spirits and then transfer successively to stronger, and for some objects, as Medusæ, no other treatment will succeed.

SOLUTION B. I.

Soft water, ...	1 gallon.
Solution A. I, ...	1 qt.
Arseniate of potassa, ...	1 oz.

Another solution with double the amount of water may be made if desired, and called solution B. II.

To preserve animals with these solutions they are, if insects or marine invertebrates, ordinarily placed first in solution B. I, but if the weather

be cool it would be better in many cases to employ first B. II, and in the case of all marine animals washing first in fresh water is desirable, though not essential. If the specimens rise to the surface they should be kept under by mechanical means. After remaining for several hours, or a day, varying according to its size and the weather, in the B. I. solution it may be transferred to A. III, and then successively to A. II, and A. I, and when thus fully preserved it may be transferred to a fresh portion of the last solution, which has been filtered clear and bright, and put up in a cabinet, when no further change will be necessary if the bottle or other vessels be properly secured to prevent the escape of the fluid by crystallization around the opening. To prevent this the stoppers, whether of cork or glass, together with the neck of the bottle or jar, may be covered with a solution of paraffine or wax in turpentine or benzole, which should be applied only when the surfaces are quite dry and clean. The length of time that any specimen should remain in each of the solutions is usually indicated by their sinking to the bottom when saturated by it. In general the more gradually this saturation with the saline matter takes place the less the tissues contract or change in appearance. In many cases, however, fewer changes than indicated above will be effectual. I have in some cases succeeded well with but two solutions below A. I. For vertebrates, except fishes, the solution A. II. will usually be found strong enough for permanent preservation, especially when the object is small or dissected. If the entire animal be preserved, when larger than two pounds in weight, it should be injected with the fluids, especially B. I. and the final A. I. or II, or an incision may be made in one side of the abdomen in vertebrates, or under the carapax of crabs, &c., to admit the fluids more freely. In preserving the animals of large univalve shells an opening should be made through the shell at or near the tip of the spire. Mammals, birds and reptiles, should be placed first in solution B. II. to obtain the best results. In cases where the use of the B. fluids would be objectionable, on account of their highly poisonous nature, a fourth dilution of solution A. I, corresponding in strength with B. I, but without the arseniate of potassa, may be substituted, and in many cases will do nearly as well, if the weather be not very hot, but the specimens in this case should be carefully watched and transferred to the stronger solutions as soon as possible, so as to avoid incipient decomposition while in the first fluids.

New Haven, Feb. 12, 1866.

4. *Researches upon the Hydrobiinæ and allied forms; chiefly made upon materials in the Museum of the Smithsonian Institution;* by Dr. William Stimpson. 55 pp. 8vo. 1865; with 29 wood-cuts. From the Smithsonian Miscellaneous Collections.—The great difficulty of studying the anatomy of the Hydrobiinæ, owing to their diminutive size, has, with few exceptions, caused conchologists to classify them merely from the form and other characters of the shell, and such parts of the animal as can be seen protruded when in motion. Hence, rather widely different views have been entertained in regard to their generic relations, some referring a part of them to the genus *Paludina*, others to *Melania*, *Leptoxis*, *Cyclostoma*, &c., while other authors have more properly proposed for the reception of certain types, the genera *Amnicola*, *Pomatiopsis*, *Soma-*

togyrus, &c. Even those who have admitted these new genera, however, still differed in regard to their family affinities, some placing certain of them in the *Melaniidæ*, others in the *Rissoidæ*, *Viviparidæ*, *Littorinidæ*, &c., while still other conchologists proposed to establish for their reception a new family, *Amnicolidæ*.

After a thorough and searching investigation of the whole subject, particularly of the structure of the softer parts and the dentition of many of these types, Dr. Stimpson arrives at the conclusion that these little snails all belong to the *Rissoidæ*, to which they had in part been referred by H. & A. Adams; though he also includes in the family the genera *Lithoglyphus* and *Paludestrina*, (referred by those authors to the *Littorinidæ*), as well as several new genera he finds it necessary to establish. He likewise suggests that *Pyrgula*, *Tricula*, *Cecina*, and *Blanfordidia* probably belong to this group; while he excludes from it the genus *Barleea*, which had been included by H. & A. Adams.

After thus eliminating the extraneous genera, and including others not previously known to belong to this family, he gives a full and clear diagnosis of the group, by which it can readily be distinguished from the families *Littorinidæ*, *Viviparidæ*, *Truncatellidæ*, *Melaniidæ* and *Valvatidæ*, with which it is more or less nearly allied, or has in part been confounded. He then defines the following six sub-families, into which the group is found to be naturally divisible:

1. *Bythiniinæ*, including *Bythinia* Gray.
2. *Rissoininæ*, including *Ressoina* D'Orb.
3. *Rissoinæ*, including *Rissoa* Frem., *Cingula* Flem., *Alvania* Risso, and *Onobia*, *Setia*, *Ceratia* and *Fenella* H. & A. Adams.
4. *Skeneinæ*, including *Skenea* Flem.
5. *Hydrobiinæ*, including *Hydrobia* Hartm., *Littorinella* Braun., *Amnicola* Gould & Hald., *Bythinella* Moq. Tand., *Stenothyra* Benson, *Tricula* Benson, *Pyrgula* Christ. & Jan, *Paludestrina* D'Orb., *Tryonia* Stm., *Potamopyrgus* Stm., *Lithoglyphus* Muhlfeldt, *Fluminicola* Stim., *Gillia* Stim., *Somatogyrus* Gill, and *Cochliopa* Stim.
6. *Pomatiopsinæ*, including *Pomatiopsis*, Tryon.

The memoir is mainly devoted to the subfamilies *Hydrobiinæ* and *Pomatiopsinæ*. Of the genera belonging to the former, extended descriptions, and excellent outline cuts illustrating the shell, animal, dentition, &c., are given of the typical species of *Amnicola*, *Bythinella*, and the new genus *Fluminicola*. Similar illustrations, and a good description are given of the type (*Amnicola lapidaria* Say,) upon which the genus *Pomatiopsis*, and the subfamily *Pomatiopsinæ*, were founded. The latter type, although a true air-breathing mollusk, living habitually out of water, is shown to breath by gills, and not, as would naturally be expected, by lungs. He remarks, however, that "it may be said to be amphibious, but only in the sense that *Succinea* and some other terrestrial mollusca are so; that is, it is capable of living for a long time under water." The foot of this type is also shown to be adapted by a peculiar construction, to a gliding mode of progression in water, and to a stepping motion, aided by the rostrum, when on land.

Farther on, he gives an extended description of the sub-family *Hydrobiinæ*, with accurate diagnoses of each of the included genera, full refer-

ences, synonymy, citations of types, &c. Of these genera, the following are new: *Tryonia* Stim., founded upon a new species, *T. clathrata* (probably extinct) from the Colorado Desert; *Potamopyrgus* Stim., founded upon *Melania corolla* Gould.; *Cochliopa* Stim., founded upon *Amnicola Rowellii* Tryon; *Gillia* Stim., founded upon *Melania altilis* Lea; and *Fluminicola* Stim., founded upon *Paludina Nutalliana* Lea.

It is worthy of note that the author has not, as is too often done, gone on to refer by guess, to his new genera, all the little shells that might be supposed to belong to them, but leaves that to be done by others who may have an opportunity to study thoroughly their softer parts, dentition, &c., and determine whether or not they really possess all the characters of the newly founded groups.

Another commendable feature in this memoir is, that the author has in each instance *distinctly stated what species he regards as the types of the new genera.* Every naturalist must be aware that much of the confusion in the nomenclature of natural history has arisen from the neglect of this simple rule in the subdivisions of the group which may afterwards take place, some retaining the original name for one group of the species, and others for others, with no chance for agreement. Many, perhaps the majority, say that, in such cases, the old name should always be used for the group including the first species, or in other words, that the first species mentioned or described under the old name, should be regarded as its type. Others, however, insist that the original name should be retained for the group including the majority of the species first described, or included; while others contend that the type most nearly agreeing with the diagnosis, or which has its characters best expressed in the name itself, should be regarded as the type of the original genus. Still others say that the first author who divides and properly restricts a genus originally founded upon heterogeneous materials, has the right to determine, arbitrarily which shall retain the old name, and which shall receive new ones. Now all such confusion is avoided by simply stating which species is recognized as the type in founding a new genus.

The work under review bears throughout marks of great care and thoroughness. The Smithsonian Institution is doing a good work for the advancement of science in publishing the results of such investigations.

M.

5. *On the method of flight of the Flying-fish;* by HORACE MANN (in a letter to F. W. Putman).—I have been watching the flying-fish today. They are very abundant, and though you may know all about them from persons more competent to see and describe than I, yet I venture to send you a few notes on them in my journal. I had supposed that they must acquire some considerable momentum below the surface before rising above it, and for that reason wished to see if the motion of the fish immediately after leaving the water was more accelerated than during the later portions of its flight (for it is obviously a true flight). I think that I have been able to discover some slight differences in the rates of motion immediately after leaving the water and later in their course; but I also think their motion is kept up by the fins, and also that the weight is sustained by them. They do not appear to leave the

water at a large angle, but otherwise; as near as I have been able to judge about 5° or 6°. They plainly have the power of altering their course of flight, so far as rising and falling, as I have seen them go over the rising surface of a not very high wave, and their flight is also almost always slightly dipping. I have also thought they sometimes altered their course to the right or left without touching the surface of the water, but it may have been owing to the wind. They will often barely touch the surface of the water and rise again, keeping on in the same or an altered course. There went a school of a dozen or twenty this very minute, rising and falling slightly, and entering the water and issuing from it again and again, and altering their course for the distance of seventy-five to one hundred yards. The motion of the fin is *not always* steady, as I have seen when they rose near the ship and the sun struck favorably upon them, for in those cases the motion was intermittent in velocity, though kept up all the time, and might be represented by a line more or less shaded. I have observed them fly thirty or forty yards without touching the water, though I should say usually they would not go more than half that distance. They do not usually rise much over a foot above the surface of the water, often much less, though one was said to have come on board the other day, and to do that I should think must have risen at least eight or ten feet.—*Proc. Boston Soc. N. H.*, x, 21.

6. *Dodo.*—On the 9th of January, Professor Owen read a paper before the Zoological Society of London on the osteology of the Dodo (*Didus ineptus*, Linn.). The materials upon which Prof. Owen's researches were based consisted of about one hundred different bones belonging to various parts of the skeleton which had been recently discovered by Mr. G. Clark, of Mahéberg, Mauritius, in an alluvial deposit in that island. After an exhaustive examination of these remains, which embraced nearly every part of the skeleton, Prof. Owen came to the conclusion that previous authorities had been correct in referring the Dodo to the Columbine group, the variations presented, though considerable, being mainly such as might be referable to the adaptation of the Dodo to a terrestrial life and different food and habits.—*Athen.*, *Jan.* 20, 1866.

IV. ASTRONOMY.

1. *Observations of Shooting Stars on the nights of Nov.* 12–14*th*, 1865.—To the accounts given in the last number of this Journal, pp. 58–61, there may be added,

(1.) *Detroit, Michigan.*—Mr. O. B. Wheeler saw on the night of the 12th–13th, between one and two o'clock, 77 meteors, and between the hours of three and four, 63. On the next night only 23 were seen between one and two o'clock. Both nights were very clear, and his eyes were kept constantly directed, during these hours of observation, toward the heavens in the general direction about 30° N. of E., and 45° high.

On the first night about one-third were of the common sort, such as are visible on every clear night. Nearly all the remainder were "cigar" shaped, and radiated from the sickle in the constellation Leo. On the next night only four of the 23 were "cigar" shaped.

(2.) *In England.*—From a report in the Royal Astronomical Society

Notices (pp. 54–57), of a verbal communication to the Society by J. Glaisher, Esq., and of a subsequent conversation, we take the following.

"On the night common to the 12th and 13th of November a watch was kept up at the Royal Observatory, Greenwich, from the hour of 6. Between this hour and 8^h two meteors only were seen; from 8^h to 12^h the sky was cloudy and no meteors were seen. At this time six observers (viz., W. C. Nash, A. Harding, F. Trapaud, E. Jones, T. Wright, and Lieut. Rikatcheff, R. I. N.) were located on an elevated part of the observatory. At 12 minutes after midnight the clouds began to break, and at 20 minutes to 1 the sky was free from clouds. At 1 o'clock the paths, zones, color, and other particulars of 29 meteors, were recorded. By 2^h A. M. the same particulars of 70 additional were noted; and by 5^h A. M. the positions, &c. of nearly 280 meteors had been secured. Before this time we knew that we had abundance of observations to determine the radiant point or points; and for a space of nearly a quarter of an hour the paths of the meteors among the stars, &c. were not noticed, but their number was simply counted. The result was that at this time the meteors of the first class were appearing at the rate of 250 per hour. Now for every meteor observed, there were at the lowest estimation two or three whose positions were not recorded; so that at least 1000 meteors were visible during the hours of 1 to 5 o'clock.

At the hour of 5 the moon was shining brightly, and many meteors were seen close to her.

Mr. Alexander Herschel was observing at Hawkhurst till nearly 3^h A. M., and he noted the positions and paths of 68 meteors, which he has laid down on a diagram, indicating very clearly a well-marked, radiant point in *Leo*.

Many of the Greenwich meteors are laid down on this diagram, and by comparing the two diagrams together it will be seen that the Hawkhurst diagram indicates the radiant point in *Leo*, within narrower limits than the Greenwich diagram. Also it will be seen that more than one radiant point is indicated in the Greenwich diagram; but they are in the same right ascension, viz., about 10^h. Now the great interest connected with this part of the results, in relation to astronomy, is that this position in *Leo* is the part of the heavens toward which the earth was moving at this time; and apparently, as soon as the earth approaches this part of the heavens, those bodies situated there become luminous. This adds another link to the sciences of astronomy and meteorology.

I think there is no doubt that the meteors observed this night were those of the November period. At Greenwich, for more than twenty years, a good lookout has been kept for the annual display of shooting-stars at the November period, but this is the first time we have seen them. It is very likely that on several occasions we have closed our watch too early. It was the knowledge of this fact that made me say, at the beginning of these remarks, that I was not surprised at gentlemen giving up watching at 12 o'clock; for it is no joke, as I know by experience, to stand motionless on a clear, cold night, hour after hour, staring, as it were, at vacancy, with perhaps one or two observations only as a reward. It is also likely that on some occasions the shower has taken place during the day, and therefore has not been visible at Greenwich at all.

Speaking of radiant points, I may remark that there are 56 already determined and well marked. Many of these determinations have been materially influenced by isolated observations of meteors observed on the same day in different years being brought together, thus indicating the same point of the heavens as the origin of the meteors. I know nothing in physical research which seemed so unpromising as isolated observations of shooting-stars did a few years ago, yet how well a patient and painstaking record of such phenomena has been repaid.

The next step in the reduction of the observations of these meteors will be to ascertain those which have been doubly and trebly observed, so as to determine their heights and velocities.

The only information I can give to-night in these respects is that with which Mr. A. Herschel has furnished me. It appears that 15 meteors observed on that night by Mr. Herschel at Hawkhurst were simultaneously observed by Prof. Adams at the Cambridge Observatory. The distances from the earth, at the beginning and end of the apparitions of five of these doubly-observed meteors, were as follows:—75 miles and 54 miles; 72 miles and 55 miles; 68 miles and 44 miles; 89 miles and 57 miles; and 114 miles and 86 miles.

These distances are somewhat greater than usual. I consider it of great importance to get simultaneous observations of other meteors; and I hope that our knowledge of the distances, &c. of these bodies will be much increased by the observations of this night."

Prof. Challis said: "What Mr. Glaisher has said confirms my experience at the Cambridge Observatory. I often looked out for the November meteors, but could not see them. I had seen the August meteors very regularly with no very great disproportion as to the numbers; but I cannot say that I saw anything more on the 12th November than on other nights. Prof. Adams has given me the particulars of his observations last 12th November. He began at 12 o'clock, and went on to about 20 minutes past 1, and during that time I think it was 120—at all events, above 100, that he saw. My experience of the August meteors has been this, that I never at that hour of the night got that number; so that it is quite clear, from the experience of the Cambridge Observatory, that the appearance of this last November is exceptional—a kind of shower such as we have not noticed before. I may also, perhaps, state that Prof. Adams told me that he found fourteen coincidences—I think twelve certain—by comparing with Mr. A. Herschel's observations; and that the average height of the meteors they ascertained was 83 miles. I mention this because, in the year 1862, I took observations myself in the August period, and compared them with observations made at Hawkhurst on that occasion, and we got an average height of 82 miles. The number of coincidences is ten; and I think the coincidence of heights at the two periods is remarkable and worthy of notice."

Mr. Prideaux said that on the night in question he had gone with two companions to the top of Primrose Hill, and that in the forty minutes they remained there they saw seventy-two meteors. His friends were perfectly inexperienced in the matter. They arrived there about 3 o'clock in the morning. During the whole of the time that they were out, somewhere about an hour and a half, they saw nearly 120 meteors.

2. *Meteoric Explosion near Charleston, S. C.*—The inhabitants of Charleston were much surprised by an unusual phenomenon, that occurred at about half past eight last evening. The air at the time was still, and a slight shower was falling. Suddenly a vivid flash of light, considerably different in character from ordinary lightning, everywhere prevailed; and after an interval of about one minute came a very heavy explosion, producing in many instances a jarring of windows, similar to an earthquake. Various conjectures of the cause were expressed; some supposing it to be lightning, others this agency, followed by the explosion of a powder magazine in one of the forts in the harbor, as the sound seemed to proceed from the southeast. On inquiry this morning, I learn from an intelligent gentleman, who, at the time, was standing upon one of the wharves, that the light was so dazzling that he involuntarily covered his eyes with his hands, and was thereby prevented from observing whence it proceeded; but that the report, after an interval of rather more than a minute, came from the south. He noticed also that the explosion was followed for some seconds by a peculiar rumbling sound, more monotonous than is usual in the reverberations of thunder. A colored sentinel before the Roper's Hospital described it as a falling star, and pointed to the southern heavens as the region from whence he saw it descend. C. U. S.

Medical College, Queen street, Charleston, December 10, 1865.

Since writing the above but little additional information has been obtained, the most important being that afforded by Capt. Boutelle of the United States Coast Survey, whose steam-cutter, the Bibb, was at the time lying off the south end of the city. He estimated the interval between the light and the report at 30 seconds; and supposed the explosion occurred in a southeasterly direction, at a distance of about 7 miles, making the fall of the body to take place over the water. As affording some evidence concerning the duration of the light, Capt. B. mentioned the circumstance, that the sentinel on deck, hearing something like the movement of a small boat under the bow of the steamer, was led to suspect an attempt at escape by some of the crew. The flash occurring at the same moment, he discovered two men in a boat just making off in that direction, whereupon he leveled his piece, as if with the intention of firing upon the refugees, who observing their peril immediately commenced their return to duty,—an instance which has perhaps never before occurred where the light of a meteor has lent itself for the support of military discipline.

An observer in the city has stated to me that the sky was much overcast at the time, so as to have concealed the path of the meteor. He noticed, however, what he called three waves of light, and also stated that the flashes revealed the outlines of the clouds in several places. Still another observer thought the light had a bluish tint. All concur in its want of resemblance to lightning. Even children in the streets were alarmed by it; and in one instance several of them ran into a shop and secreted themselves until after the explosion.

A conductor on a South Carolina railroad observed the light of the meteor at a place 75 miles north, or north-by-west, of the city; from which it would seem that its course was from N.W. to S.E. C. U. S.

3. *On the Heat attained by the Moon under Solar Radiation;* by Mr. J. P. Harrison.—On the assumption that the moon's crust is constituted geologically like the earth different parts of her surface would not attain the same degree of heat. Nearly two-thirds of the hemisphere turned toward us is honeycombed with gigantic craters, and covered everywhere with the *débris* of stupendous volcanic eruptions. That region, should, therefore, absorb less heat, in proportion to its reflecting properties. On the other hand, the greater portion of the dark surface of the moon would absorb and radiate heat in the inverse ratio to their non-reflecting surfaces. The whole surface of the moon being exposed in turn for from about thirteen to rather more than sixteen days to the solar rays, in speaking of the heat which our satellite attains it must not be considered that equal surfaces illuminated—e. g., at the first and third quarters—are equally *heated* because so illuminated, or without reference to the duration of the sun's radiation upon them. On the contrary, at the day of first quarter, the region of the moon which has received the rays of the sun for a mean period of nearly three and three-quarter days, after being subjected to the most intense cold during the moon's long night, has been gradually warming up to the time it completes its first quarter; the region opposite the earth having received the heat of the sun's rays for only about four and twenty hours—a period manifestly insufficient for any surplus heat to have been absorbed, even if the region had been favorable for storing radiant heat. At the period of last quarter, on the other hand, the surface illuminated will have been heated twice as long as at the first quarter—namely, for a mean duration of seven and a half days—and not only so, but at the time when the moon completes her third or last quarter, a similar surface to that at first quarter will have received the heat of the sun's rays for 360 in place of 24 hours, with this additional peculiarity, that the surface generally will be a good absorber of heat. The heat of the moon at the last quarter might, on like grounds, be shown to be greater, or certainly not less, than at the full. It will be sufficient, however, to point out that at the period of maximum heat, that portion of the moon's fully-illuminated hemisphere opposite to us, and which radiates heat directly toward the earth, is not heated so intensely at the full as at the last quarter, or for a day or so after that phase; the ratio in favor of the latter portion being nearly two to one, whilst the ratio in favor of the last quarter compared with a corresponding region in the first quarter is rather more than fifteen to one; the measure being the duration of solar radiation, without reference to the surfaces on which it falls.

The author exhibited a curve of the mean temperature at Greenwich for fifty years, showing that the period of the greatest heat of the lunar surface synchronized with the period of greatest monthly cold in the terrestrial atmosphere, and conversely.—*Proc. Brit. Assoc., Reader, Oct.* 7.

4. *Elements of the asteroid* (85).—The following elements are given by Dr. Peters for the asteroid (85).

$$M = 334^\circ\ 10'\ 43''.7, \qquad i = 11^\circ\ 55'\ 35''.4,$$
$$\pi = 321\ \ 45\ 18\ .7, \qquad \varphi = 11\ \ 10\ \ 56\ .1,$$
$$\Omega = 203\ \ 50\ 42\ .4, \qquad \mu = 818''.16574,$$
$$\log a = 0.4247769.$$

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the Manufacture of Cast Steel; its Progress and Employment as a substitute for Wrought Iron;* by H. Bessemer.—This important paper, which will be printed *in extenso* in the annual volume, opened with a review of the inventions which had finally resulted in the establishment of "Bessemer" ironworks throughout the country. It pointed out at some length how the disadvantage of the old fixed converting vessel was remedied, and other improvements introduced. In 1839 the trade of Sheffield received an enormous impulse from the invention of Josiah Heath, who patented in this country the employment of metallic manganese, or, as he called it, "carburet of manganese;" the addition of a small quantity of this metal, say from half to one per cent, rendered the inferior coke-made irons of this country available for making cast-steel. It removed from these inferior qualities of iron their red shortness, and conferred on the cast-steel so made the property of welding and working soundly under the hammer. Mr. Heath, supposing himself secure in his patent, told his licensees that if they put oxyd of manganese and coal-tar or other carbonaceous matter into their crucibles along with the blister steel it would do as well and be much cheaper than the carburet of manganese he was selling them; in effect it was the same thing, for before the steel was melted the carbon present reduced the oxyd of manganese to the metallic state, so that the patent carburet of manganese was formed in the crucible in readiness to unite with the steel as soon as it became perfectly fused. But the law decided that this was not Heath's patent, and so the good people of Sheffield, after many years of litigation, were allowed to use it without remuneration to the inventor. Manganese had now been used for many years in all cast-steel works in Europe. It mattered not how cast-steel was made, since manganese added to it necessarily produced the same beneficial changes. No one appreciates the fact better than the unfortunate Mr. Heath, as evidenced by his patent of 1839, in which he declared that his invention consisted in the use of "carburet of manganese in any process whereby iron is converted into cast-steel." Had Heath seen in his own day the Bessemer process in operation he could not have said more. With this patent of Heath's expired, and become public property, coupled with the universal addition of manganese and carbon to cast-steel, it would naturally be supposed that the author, in common with the rest of mankind, would have been allowed to share the benefit which Heath's invention had conferred on the whole community, but it was not so. The reading of the author's paper on the subject, at Cheltenham, in 1856, led to great expectations as to the value of the new process, and licenses to manufacture malleable iron, under the patent, were purchased by ironmasters to the extent of 25,000*l.* in less than twenty-five days from the reading of the Cheltenham paper. Great excitement existed at the moment in the iron trade, and many persons seemed to covet a share in an invention that promised so much. There was consequently a general rush to the Patent-office. Some of the gentlemen who applied even repatented some of the writer's own patents, while others patented things in daily use, in order that they might be considered new, when added to the products of the new pro-

cess. The paper described the features of the numerous patents applied for within six weeks of the reading of the paper at Cheltenham, and remarked that if that long series of patents could have been sustained in law, it would have been utterly impossible for the author to have employed manganese with steel made by his process, although it was considered by the trade impossible to make steel from coke-made iron without it.

Soon after the reading of the Cheltenham paper, several rough trials of the Bessemer process were made privately, by persons in the iron trade, and defects discovered which were supposed by practical men to be wholly fatal to the invention. The press then spoke of the utter impracticability of the process, and of regrets that the high expectations originally formed were so fallacious; but the storm gradually subsided, and the process and its author were soon entirely forgotten. Imperfections in the process there certainly were, but the author had had the most irrefragible proof of the correctness of the theory on which his invention was based, and also of the fact that the reasoning on which it was condemned by the trade was in itself wholly fallacious. He therefore decided not to argue the question against a hundred pens, but energetically to prosecute his experiments, and to remain silent until he could bring the process to a commercial success. When, at the expiration of three years of incessant labor on the part of himself and his partner, Mr. Longsdon, and an expenditure of more than 10,000*l.*, the process was again brought before the public, not the slightest interest was manifested by the trade. This was discouraging, and one of two things became imperative; either the invention must be abandoned, or the writer must become a steel manufacturer. The latter alternative was unhesitatingly accepted, and Messrs. Henry Bessemer & Co. determined to erect a steel works at Sheffield, in the very heart of the stronghold of steel making. At these works the process had ever since been successfully carried on; it had become a school where dozens of practical steel-makers received their first lessons in the new art, and was the germ from which the process had spread into every state in Europe, as well as to India and America. By the time the new works at Sheffield had got into practical operation, the invention had sunk so low in public estimation, that it was not thought worth paying the 50*l.* due at the expiration of three years on Mr. Mushet's large batch of manganese patents. They were consequently allowed to lapse, and become public property. The author had therefore used without scruple any of the numerous patents for manganese without feeling an overwhelming sense of obligation to the patentee. At the suggestion of the author, works for the production of manganese and alloys were erected by Mr. Henderson at Glasgow, who now made a very pure alloy of iron and manganese, containing from 25 to 30 per cent of the latter metal, and possessing many advantages over *Spiegel Eisen*, which it would doubtless replace. (Specimens of iron manufactured by this process and afterwards bent and tested in every way were exhibited.)

The paper proceeded to notice some of the more important applications of steel as a substitute for wrought iron. In no case, it was pointed out, was this change of material more important than in the construction of ships, for in no instance were strength and lightness more essential. Bessemer cast-steel ship-plates were then described, and their advantages

illustrated by facts and statistics. The advantages had not escaped the attention of Mr. Reid, the Constructor of the Navy, and they would doubtless soon have substantial proof of what might be effected by the employment of steel in the construction of ships of iron. The application of steel to projectiles was next considered. Next its uses for railway purposes, such as the manufacture of engine cranks, axles, tires of wheels, and even rails. The paper described successful experiments which had been made in the use of cast-steel for these purposes. The paper concluded by stating that cast-steel was now being used as a substitute for iron to a great and rapidly increasing extent. There were now seventeen extensive Bessemer steel works in Great Britain. There were at present erected and in course of erection in England no less than sixty converting vessels, each capable of producing from three to ten tons at a single charge. When in regular operation, those vessels were capable of producing fully 6,000 tons of steel weekly, or equal to fifteen times the entire production of cast-steel in Great Britain before the introduction of the Bessemer process. The average selling price of this steel is at least 20*l.* per ton below the average price at which cast steel was sold at the period mentioned. With the present means of production, therefore, a saving of not less than 6,240,000*l.* per annum might be effected in Great Britain alone, even in the present infant state of the steel manufacture.

In the discussion which followed, in reply to Mr. Bramwell, Mr. Bessemer said they had proof that they could produce malleable iron, but at the same time the bulk of iron ores were so impregnated with phosphorus and sulphur that it was extremely difficult. They, however, were now using hematite ore at the rate of 4,000 tons weekly. As regards waste, taking the average of the last 10,000 tons made, he found that there was $12\frac{3}{4}$ per cent difference between the weight of pig-iron put into the furnace and the cast-steel ingots obtained. But from this should be deducted 5 per cent of impurities, and 5 per cent the usual waste of pig-iron in melting, so that only $2\frac{1}{2}$ pr. ct. of iron was wasted in the process.

Mr. Lloyd said, as a practical ironmaster, he could bear testimony to the value of Mr. Bessemer's process. He had tried it for three years, and had accomplished all that Mr. Bessemer had stated.

Dr. Fairbairn said there could be no doubt that a great change would sooner or later take place in the manufacture of iron. Hitherto the great difficulty in the manufacture of steel had been the want of uniformity. If Mr. Bessemer by his process could always secure uniformity in the quality of his manufacture, the probability was that steel would take the place of wrought iron in all large works, not only on account of its greater brightness, but of its increased strength.

Dr. Price stated that the introduction of the sulphur was due in a great measure to the fuel employed; and as it has been proved by careful research that all the phosphoric acid in the materials melted at English works was reduced to phosphorus, which combined with the iron, it would be of great value to the ironmaster if Mr. Bessemer could state what was the maximum amount of phosphorus that pig-iron might contain to be available for conversion by his process, as it could then be predetermined whether the iron would suit for this purpose.

Mr. Bessemer said, 0·1 pr. ct. of phosphorus might be present in the pig. —*Proc. Brit. Assoc., Reader, Oct.* 21.

2. *Chicago Academy of Sciences.*—We have received the first Bulletin of this new institution, in the form of a neatly printed pamphlet of sixty-three pages. It contains the Act of Incorporation, Constitution and By-Laws, and Lists of Officers, Members, and Correspondents; together with a lucid historical sketch of the establishment and progress of the Academy, by Dr. Andrews, the President; also, a very full and complete report on the condition of the Museum and Library, by Dr. Stimpson the Secretary and Mr. Frost the Librarian.

The following gentlemen are the Officers of the Academy: Dr. Edmond Andrews, President, Daniel Thompson and Benjamin F. Culver, Vice-presidents; Dr. William Stimpson, Secretary; and George H. Frost, Librarian. The officers of the Board of Trustees are the following: I. Young Scammon, President; William E. Doggett, Vice-president; George C. Walker, Secretary and Treasurer; and Robert Kennicott, Director of the Museum.

From the Report of the efficient Secretary, Dr. Stimpson, we learn that there are already in the Museum nearly forty thousand specimens of Mammals, Birds, Birds-eggs, Reptiles, Insects, Crustacea, Annelids, Mollusca, Echini, Corals, Plants, Fossils, Minerals, &c.; and Mr. Frost's Report shows that the Library, though yet small, contains a number of valuable works on various departments of Science.

Mr. Kennicott, the energetic Director of the Museum, is now with a corps of young naturalists, in Russian America, attached to the party exploring the route for the overland Russo-American Telegraph; and will doubtless bring back from that distant and little known country, large accessions to the Museum of interesting objects of Natural History.

We learn that the Academy will soon commence the issue of liberally illustrated Transactions and Proceedings; and that during next summer a fine fire-proof building will be erected for the reception of the Museum and Library, on a valuable block of ground given for that purpose.

The establishment and liberal support of such Institutions as this and the Chicago Astronomical Observatory are facts that speak well for the intelligence of the citizens of Chicago. They have already shown us that they possess the energy, the capital, and the skill to build up a great and flourishing city in an astonishingly brief space of time, and now they seem to be equally in earnest when they speak of soon making their city "the scientific as it is already the commercial center of the west."

3. *On a Second Journey into Western Equatorial Africa;* by P. B. Du Chaillu.—Mr. Du Chaillu stated that he left London on the 5th of August, 1863, and on the 9th of October in the same year he reached the mouth of the Fernand Vaz River, on the African coast, immediately to the south of the equator. The ship in which he had sailed had to land its cargo in native canoes, and in going ashore himself with his scientific instruments he was capsized, and the most valuable part of the instruments lost. A new set from England was ordered, but it did not reach him till August in the following year—a delay which he employed in making collections of Natural History, and transmitting them to England. He then advanced eastward to the Ashira country, where he had been on his former journey, and where he was well remembered and kindly received. The country from the coast eastward rises by successive

steps. First, there is a belt of low land near the sea, then a succession of hilly ranges running northwest and southeast, with valleys between, the ranges increasing in altitude toward the interior, and the passes over them ranging (by aneroid and boiling-point) between 1,864 and 2,400 feet. The greater part of the country is covered with dense forest, through which are narrow paths leading from village to village; but from the Ashira country eastward there are three main lines of path—one to the northeast, another to the east, and the third to the southeast. The tribes are divided into clans, and each village has its own chief, the inhabitants always belonging to the clan of the mother. The villages are more populous and larger than those near the coast. In reading the works of Grant, Speke, and Burton, he observed many words which were identical with or which closely resembled words used in the district he had traversed, and he had no doubt that the tribes of Western and Eastern Africa had formed originally one people. After he and his party had been about three weeks in Ashira, a visitation of small-pox ravaged the country. Misery and destruction were spread on every side, and he was himself reduced to a most dejected and prostrate condition. To increase his difficulties, the chief, Olenda, his old and tried friend, died of the disease, and the traveller was accused of causing his death by witchcraft. He was, moreover, prohibited from continuing his march eastward through the Apingi country (the route which he had followed on his former journey), owing to the Apingi king having died soon after his visit, and his death being attributed to the white traveller, who was believed to have wished to carry the spirit of the chief back with him to his own country. He was ultimately enabled to continue his journey eastward by the Otando country. In the course of the journey he met with a singular diminutive wandering tribe, a kind of negro gypsies, of lighter color than the negroes, and having shorter hair on the head and hairy bodies. The average height of the women, a few individuals of whom he measured, was only from 4 feet 4 inches to 4 feet 5 inches. After he had advanced 200 miles farther than any European had yet penetrated, his undertaking was brought to an unexpected termination by an accident. This was at the village of Mooaoo Kombo, 270 miles from the mouth of the Fernand Vaz. One of his men fired off a gun accidentally, and two of the natives—a man and a woman—were unfortunately killed. The villagers became at once excited, and attacked himself and his party with their spears and poisoned arrows. He could not blame them for the suspicion and irritation under which they acted, and he, therefore, forbade his men to fire on them. He then ordered his followers to retire, which they did, at first in good order, while he himself remained in their rear, as he believed he was in a less degree than they an object of resentment to the excited natives. A panic, however, soon seized his party; he found it impossible to check them; they threw away all the articles which they carried; he himself felt compelled to join them in their flight and to part with many of the most valuable things which he had in his possession. The result was that, although his men energetically rallied, he lost all his instruments as well as his ammunition, and all that could have enabled him to continue his journey with advantage. He lost also the whole of the Natural History collec-

tions he had made in the interior, and a fine series of photographs of the scenery and natives. He saved, however, his chronometers, which he himself carried, and his journals, with one set of his astromomical observations. He at once, therefore, retraced his steps westward, and immediately afterward made his way back to England.—*Proc. Geograph. Soc., Jan.* 8.

4. *On Beef and Pork as sources of Entozoa;* by Dr. Cobbold, F.R.S.—This paper brought together all the evidence bearing on the question as to the source of tapeworms in the human body, and especially controverted an opinion recently enunciated in the columns of the *Natural History Review*, in which journal it was maintained that the *Tænia* would cease to infest us if the pig was deprived of the privilege of acting "the part of a communicating medium." It was shown that beef was a much more fertile source of tapeworms than pork; this conclusion being drawn not only from data furnished by the author's experimental researches, but also from the fact of the much greater prevalence of the hookless tapeworm (*Tænia mediocanellata*) as compared with that of the hooked species (*Tænia solium*). An animated discussion followed, in which Professor Van der Hoeven, Professor J. H. Bennett, Dr. Fleming, Dr. Crisp, Dr. Anderson, Dr. Patterson, Messrs. Turner, Power, and others took part.—*Proc. Brit. Assoc., Reader, Sept.* 30, 1865.

5. *Illumination under the Microscope.*—At the late *soirée* at University College, two forms of Mr. Smith's (of the United States) illumination for opaque objects under high microscopic powers were exhibited. One was constructed by Messrs. Smith and Beck, of Cornhill, and the other by Messrs. Powell and Lealand. The first form closely resembles the American contrivance—so closely, indeed, that it is difficult to know in what the difference between the two consists. A brass box intervenes between the end of the microscope tube and the objective. This is pierced at the side by an aperture opposite which a table lamp is placed; within the box is a small silvered mirror, which receives the light from the lamp, and throws it down through the objective upon the object. This contrivance, though it works admirably with such a power as the one-fifth inch, is objectionable, from the fact that it cuts off half the pencil of rays proceeding to the eye of the observer. The second form —that exhibited by Messrs. Powell and Lealand—is superior to that of Smith and Beck, and differs from the American plan in having a reflector of plain glass. The result of this alteration of the original plan is that whilst sufficient light is thrown down to illuminate the object, the rays proceeding from the latter are not partially cut off. This modification applied to the one-twelfth inch gave splendid results, and the makers allege that it may be used with one-twenty-fifth or one-fiftieth inch glasses with equal advantage.—*Reader, Dec.* 23.

OBITUARY.

Lovell Reeve, the publisher, died on the 18th instant at his house in Henrietta street, after thirteen months' severe suffering, aged fifty-seven. Mr. Reeve was well known, not only as a publisher, but also as an author, his contributions to the natural history of the Mollusca being both numerous and valuable. They are to be found in the volumes of the "Proceedings of the Linnean Society," of which body Mr. Reeve was a fellow.

He was also the author of "The Conchologist's Nomenclature," 1845; "Conchologia Systematica," 1841–3; "Conchologia Iconica," 1842–5; and "Initiamenta Conchologia," 1846.—*Reader, Nov.* 25.

Prof. FORCHHAMMER, of Denmark, distinguished in the departments of geology and mineralogy, and Secretary of the Academy of Sciences of Copenhagen, died in December last.

VI. MISCELLANEOUS BIBLIOGRAPHY.

1. *Mineral Oil. Prospectus of the Indian Creek and Jack's Knob (Cumberland and Clinton counties, Kentucky) Coal, Salt, Oil etc. Company, with a Geological Report on the Lands;* by Dr. J. S. NEWBERRY. 20 pp. 8vo. Cincinnati: 1866.—Dr. Newberry, as early as 1859, in a paper on the Rock Oils of Ohio, published in the Ohio Agricultural Report for that year, gave an excellent review of the subject of mineral oil, including views on its nature and origin. He pointed out the rocks in the United States affording it, referring the oil of Ohio to the Waverly sandstone as its principal repository, but to the Hamilton shales beneath as probably its original position, the same rock which he states affords the oil of Canada West.

In the Report whose title is above given he makes observations on the geological structure of the Cumberland Oil Region (Kentucky) from which we take the following facts. The "oil-belt" seems to cover an area on the line of the great anticlinal axis which runs parallel with the Appalachians, and separates the eastern and western coal-fields of Kentucky, bringing the older Silurian rocks over a large region in Kentucky and Tennessee to the surface. The great wells of the Cumberland Valley, "from which tens of thousands of barrels of oil have flowed," descend two hundred feet into the Lower Silurian Blue Limestone formation. There are here bituminous shaly strata overlaid by sheets of thin-bedded compact limestone; and these are covered by 500 feet of shales of the Devonian and Subcarboniferous formations, the whole much upheaved, folded or contorted and faulted. These features prevail from Lincoln and Casey Cos., on upper Green River, through Adair and Russell, Cumberland and Clinton Cos. in Kentucky, and Overton and Jackson Cos. in Tennessee; and over this area at numerous localities oil has been found; but whether all parts will be productive in oil remains to be demonstrated. The region about Burksville, Cumberland Co., is one of the proved oil centers. It is supposed that the Obeys river region, in Overton Co., will be productive. To the north, in Lincoln and Casey Cos., the old salt wells, known as the Alford, the Shanks and the Evans, are flowing oil wells, and seem to point out this also as a center of production.

2. *Geological Survey of California.* J. D. WHITNEY, State Geologist. PALEONTOLOGY, Volume II, Section I, Part I. *Tertiary Invertebrate Fossils;* by W. M. GABB. 38 pp. 4to. February, 1866. Published by Authority of the State of California.—This first part of the second volume of the Paleontology, just issued, contains descriptions of about fifty new species of fossils, besides also of others before known that were imperfectly described, or were not figured. The species are all referred to the Miocene and later Tertiary, no beds having been recognized by Mr. Gabb as positively Eocene,—who observes, however, that future

researches may modify much present conclusions. The plates are not yet quite ready for delivery. There are on hand for description in the continuation of the Paleontology, additional Tertiary species, besides fifty or more new Cretaceous, a few Jurassic and Triassic, some Vertebrate, and many Plants.

3. *Geology of Arisaig, Nova Scotia.*—A paper on the Geology of Arisaig, Nova Scotia, by the Rev. Dr. Honeyman, F.G.S., is contained in the Quarterly Journal of the Geological Society of London, for November, 1864. The strata of the region are Silurian, and have a striking resemblance in fauna to the British Upper Silurian. The whole thickness, as estimated, is 870 feet.

4. *An Outline Geological Map of Tennessee, including portions of Mississippi, Alabama and Georgia;* by NELSON SAYLER. Published by E. Mendenhall. Cincinnati, Ohio. 1866. Price $2.00.—This map is mainly a copy of that published by Prof. James M. Safford in his Geological Report of Tennessee. It gives by means of lines and colors a general idea of the areas occupied by the several formations, with less of detail than in the original by Mr. Safford, and is accompanied by a section of the state stated to be "arranged from J. M. Safford's Geological section." The map will prove a useful one to all interested in the geology of Tennessee, or in the general geology of the United States.

5. *Die Steinkohlen Deutschlands und anderer Länder Europa's;* by Prof. Dr. H. B. GEINITZ, Prof. Dr. H. FLECK, and Dr. E. HARTIG. Vol. I, Geologie, 420 pp. 4to, with a thick 4to volume of 28 plates. Munich, 1865. (B. Oldenbourg. Price for the volume 12 thlr.)—The first of the two volumes of which this great work is to consist has just been issued in two parts, the first including the text, the second the plates. This volume completes the Geological part of the work, and is prepared by Dr. Geinitz; the second will take up the subjects of History, Statistics, and Applications to the Arts, and is the work of Prof. Fleck and Dr. Hartig.

The Geology treats of the Coal regions and formations of Germany and the rest of Europe. It takes up, in order, the different positions of fossil coals commencing with the Azoic beds, and the kinds of coal; the stone coal formation of the Kingdom of Saxony; of the Prussian province of Saxony, the southern border of the Harz, the Thuringian Forest, the Bavarian Oberpfalz, and the Schwarzwalde; in Saarbeck and Rheinpfalz (contributed by von Rönne); of the vicinity of Aachen (by Dr. von Dechen); of Westphalia, and near Osnabrück in Hanover; the Silesian, continued in Bohemia and Moravia (by Bergmeister Schütze); the Brown coal of the Alps, in the Keuper and Lias; and of Austria, in the Cretaceous and Tertiary; the stone coal of Switzerland, Savoy, Italy, Portugal and Spain; of Belgium and France; of England and Scotland; Sweden; Denmark; Russia. Dr. Geinitz treats his subject in a masterly manner, it being a department in which he has long labored and with many original results and publications. Sections are given of the beds; descriptions of the rocks, and of the intersecting dikes when they occur; comparisons of fossils; sections of mines and the associated rocks; and whatever, in fact, is of interest and importance connected with the geology of coal. The volume of plates includes geological maps of the various countries or regions that contain coal, and profile sections of coal beds; and are

prepared and engraved in a style of great perfection and beauty. Some of the folded plates are six times the size of the quarto page.

The 2nd volume, treating of practical and economical subjects connected with coal, is soon to be issued at the price of 9 thalers.

6. *Revue de Geologie pour les années*, 1862, 1863; by M. DELESSE, Ingenieur en Chef des Mines, etc., and M. LAUGEL, Ancien Ingenieur des Mines, etc. 412 pp. 8vo. Paris, 1865. (M. Dunod.)—A portion of this work appeared in the Annales des Mines, and was noticed by us in volume xl, at page 272. The volume will be welcomed by geologists, as it is an excellent general review of the progress of the science for the years mentioned, and the only one accessible to them. It commences with a preliminary notice of periodicals and works issued during the period, and then takes up the different departments of the subject in the following order: Recent Changes; Systems of Mountains; Rocks; Metamorphism; Geogony, or the origin of metalliferous deposits, changes of level, etc.; Facts relating to the successive formations and their fossils, commencing with the Paleozoic; Geology of particular regions or localities, and geological maps. An extensive circulation of the volume would tend greatly to the progress of geological science. This is the third volume in the series issued by MM. Delesse and Laugel, the *first* covering the year 1860, and the *second* 1861.

7. *Om de i norge forekommende Fossile Dyrelevninger fra Quartæperioden, et Bidrag til von Faunas Historiæ;* af Dr. MICHAEL SARS (Prof. in the Christiania University). 136 pp. 4to, with 4 lithographic plates. Christiania. 1864.—This memoir is a description of the Post-tertiary of Norway and its fossils, especially of southern Norway, where there are no Tertiary or Mesozoic strata. No Tertiary exists, in fact, in any part of Norway. At one period in the Post-tertiary the land about Christiania was 500 feet below its present level, so that a deposit of clay was formed containing a fauna of arctic character. Previous to this, as the marks of erosion and groovings over the rocks beneath the clay show, the land was covered with ice to a height of 5000 feet above the sea; and the ice is stated to be the ice of an icy sea. Subsequently to this glacial epoch, there was another in which the seashores were about 150 feet above the present level, and then a fauna of a milder climate, more southern in character, existed along the coasts. The author distinguishes consequently, two epochs in the Post-tertiary (Quarternary) of Norway; a Glacial and a Post-glacial [corresponding, apparently, to the Glacial and Champlain of North America.] The fossils of both of these eras are described in the memoir.

8. *Materialen zur Mineralogie Russlands;* von NIKOLAI V. KOKSCHAROW. Fourth volume. St. Petersburg, 1861.—This continuation of the great work of von Kokscharow, on Russian Mineralogy, treats of the species Æschynite, Euclase, Magnesite, Brucite, Epidote, Orthite, Planerite, Rutile, Melanochroite, Xanthophyllite, Beryl, Pyrrhotine, Chalcopyrite, Kotschubeite (variety of Clinochlore), Karelinite, Linarite, Talc, Volborthite, Silver, Graphite, Rhodonite and Samarskite.

9. *Mind in Nature, or the origin of Life and the Mode of Development of Animals;* by HENRY JAMES CLARK, A.B., B.S., Adjunct Professor of Zoology in Harvard University, etc. 322 pp. 8vo, with over 200

illustrations. New York. 1865. (D. Appleton & Co.)—The title of Mr. Clark's work claims more than he or any author can at the present time fulfil. The work however contains the results of much original observation and is a valuable contribution in illustration of the nature of life and animal development. The author is one of the few investigating microscopists of the country, and has labored with great thoroughness and success among the lower forms of life, and also in the department of embryology, in both of which directions the work gives details of structure of great value. Some of his conclusions will be questioned by other zoologists, and among them, with much reason, his raising the Protozoa to the rank of a distinct Branch or Subkingdom coördinate with the four distinguished by Cuvier, and his views on spontaneous generation. But in a brief notice we cannot properly discuss these points, or any of the many of deep importance which the work brings forward. It contains some personalities which we think had better have been omitted. The illustrations are numerous and excellent.

10. *The Record of Zoological Literature.* 1864. Volume First. Edited by ALBERT C. L. G. GUNTHER, M.A., F.Z.S., etc. 634 pp. 8vo. London. 1865. (John van Voorst.)—This Record contains a general review of the Zoological works and memoirs published during the year 1864. It has been prepared with care, and should be in the hands of all who desire to keep up with the progress of Zoological Science.

11. *On some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay;* by W. KITCHEN PARKER, F.Z.S., and Prof. T. RUPERT JONES, F.G.S.—From the Philosophical Transactions, 1865. A memoir both of great zoological and geographical interest.

12. *Principes de Thermodynamique;* par PAUL de SAINT-ROBERT. viii and 210 pp. 8vo. Turin, 1865. (J. Cassone et Cie.)—The author of this volume has brought together into one view the elements of the new science of Thermodynamics,—the science that treats of the mechanical effects due to heat, and of the heat produced by mechanical agents. Those who have read the papers of Carnot, Mayer, Joule, Thomson, Rankine, Clausius, Helmholtz, Hirn, &c., will find little that is new in this volume. The only portion for which the author claims novelty is the seventh chapter, which treats of the motion of balls in the bore of fire-arms. To those who wish to find the mathematical principles of Thermodynamics in a single volume, developed in an exceedingly lucid and simple manner, we commend this book of Saint-Robert. H. A. N.

13. *Musée Teyler. Catalogue Systématique de la Collection Paléontologique;* par Dr. T. C. WINKLER. 2nd and 3d Livraisons. Harlem. 1864, 1865. (Les Héritiers Loosjes.)—These two parts carry this work from the 125th to the 394th page, and are devoted to the Mesozoic era, that is, the Triassic, Jurassic and Cretaceous periods. The work is a model for such catalogues, being quite perfect in its method, very full in its synonymy and references, and of remarkable beauty and distinctness in its varied typography. The Physical Cabinet (Cabinet de Physique) of the Teyler Museum at Harlem is under the direction of Dr. V. S. M. van der WILLIGEN; and the Cabinet of Paleontology, Geology, and Mineralogy under that of Dr. T. C. Winkler, to whom all offers of exchange in

these three departments should be sent. The Teyler Museum contains the remarkable head of the Mosasaurus from Maestricht, the various specimens of Icthyosaurus described by Bronn, several species of Pterodactyl described by H. von Meyer, etc.

14. *The Birds of North America.*—D. G. Elliot of New York (27, W. 33d st.) proposes to publish a work to contain all the new and unfigured birds of America, to be issued in Parts, 19×24 inches in size, containing each five plates colored by hand, with a concluding part of text; price for each part, ten dollars. Only 200 copies will be published. Mr. Elliot is author of a Monograph of the Pittidæ or Ant Thrushes, in one volume imperial folio, with 31 plates, and a Monograph of the Tetraoninæ, Grouses, one vol. royal, with 25 plates; in each the birds, with two exceptions only, are represented of life-size. Subscriptions are requested.

15. *Chambers's Encyclopedia*—a Dictionary of Universal Knowledge for the People; illustrated by wood engravings and maps.—Parts 100 and 101, carrying this Encyclopedia to the word *Saxon*, have just been issued by the American Publishers, J. B. Lippincott & Co.

C. F. Gauss' Werke;—a reprint of Gauss's works, by the Royal Society of Göttingen.

British Conchology; by John Gwynn Jeffreys, F.R.S., &c. Vol. III. Marine Shells. London, 1865. (Van Voorst).

History of the Mathematical Theory of Probability from the time of Pascal to that of Laplace; by J. Todhunter, M.A., F.R.S. London, 1865. (Macmillan & Co.)

British Hemiptera, vol. I; by John W. Douglas and John Scott. London, 1865. Published by the Ray Society. (R. Hardwicke).

Prehistoric Man: Researches into the Origin of Civilization in the Old and New World; by Daniel Wilson, LL.D. 2nd edition. London. (Macmillan & Co).

Chart of Fossil Crustacea; by J. W. Salter and H. Woodward, with a descriptive catalogue: 490 figures. London. 1866. (J. W. Lowry & Tennant).

Comparative Anatomy of the Vertebrate Animals; by Professor Owen. Announced as to consist in three volumes. The first has been issued, the second will appear in March, and the third before summer.

The Animal Creation: a popular introduction to Zoology; by Thomas Rymer Jones, F.R.S., Kings College, London.

Reliquiæ Aquitanicæ; being contributions to the Archeology and Palæontology of Périgord and the adjoining provinces of Southern France; by Edouard Lartet and Henry Christie. London, 1866. (H. Baillière, Regent St.)

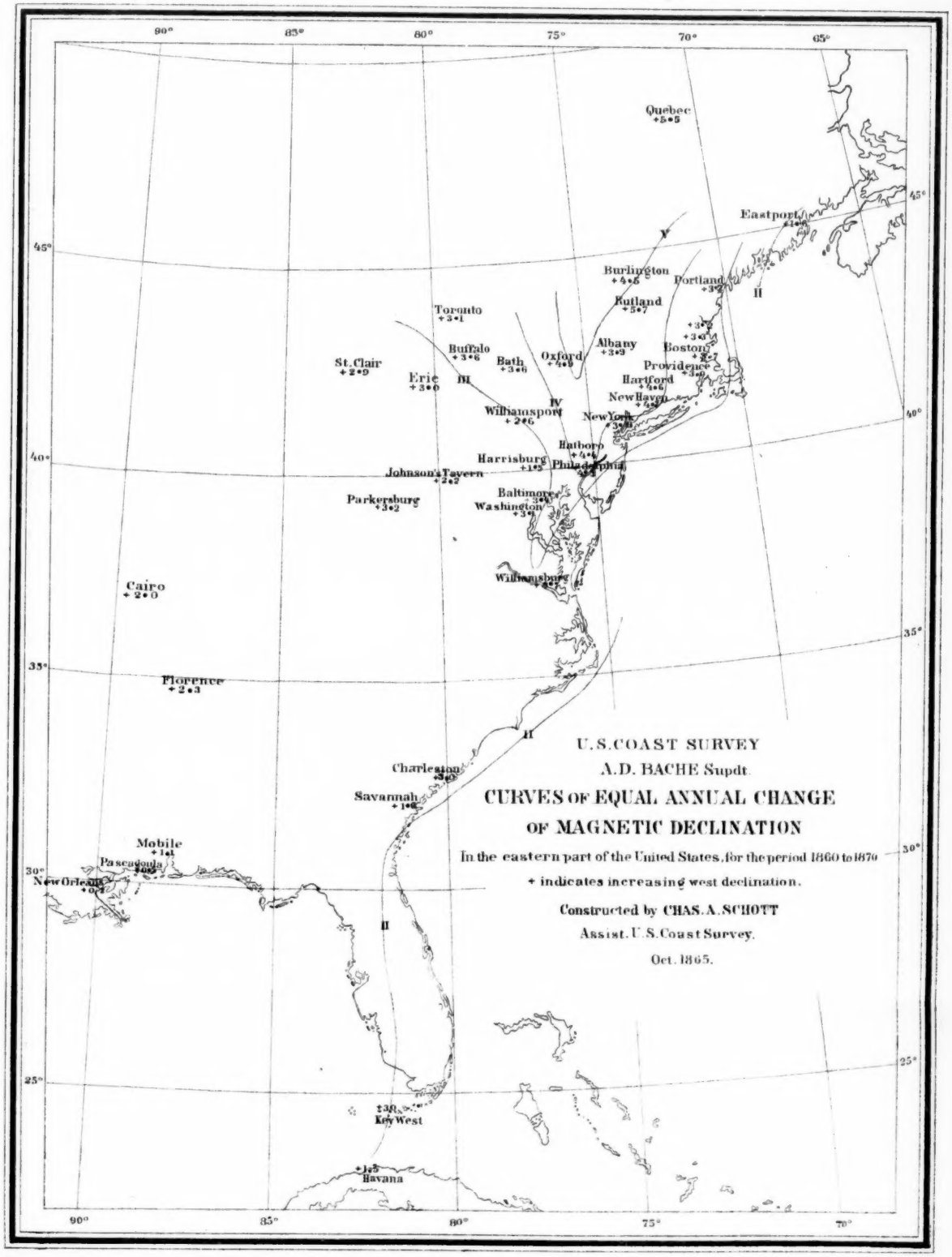
Meteorologiske Jagttagelser, par Christiania Observatorium. 1864. Christiana, 1865.

Meteorologische Beobachtungen aufgegeichnet auf Christiania Observatorium. I. Band, Letzte Lieferung. 1837–1863. Christiania, 1865.

Norges Ferskvandskrebsdyr. Förste Afsnit, Branchiopoda; I. Cladocera, Ctenopoda (Fam. Sididæ and Helopedidæ); by G. O. Sars. 72 pp. 4to, with 4 lithographic plates. Christiania, 1865.

Annals of the Lyceum Nat. Hist., N. York, Vol. VIII, Nos. 6 and 7, November, 1865.—Page 155, Notes on some terrestrial mollusca, with descriptions of new species; *T. Bland.*—p. 174, List of birds from New Grenada, with descriptions of new species; *G. N. Lawrence.*—p. 178, List of birds from Nicaragua, with descriptions of new species; *G. N. Lawrence.*—p. 185, On the Mineralogy of New York Island; *S. C. H. Bailey.*—p. 194, Catalogue of the Mollusca of Little Gull Island, Suffolk Co., N. Y.; *S. Smith.*—p. 195, Remarks on the Spongidæ of Cuba and Description of a new species of Ambulyx from Brazil; *A. R. Grote.*—p. 207, Descriptions of new species of Pupadæ; *E. S. Morse.*

Field Notes retouched, embracing observations upon the Geology, Minerals, and Physical Geography of the States on the waters of the Upper Lakes, by Col. Chas. Whittlesey, of the late Geological Surveys in Ohio, Michigan, Wisconsin and Minnesota, with maps and illustrations.—A work in 8vo, with the above title, is in the press at Cleveland, Ohio.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Providence
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Baltimore
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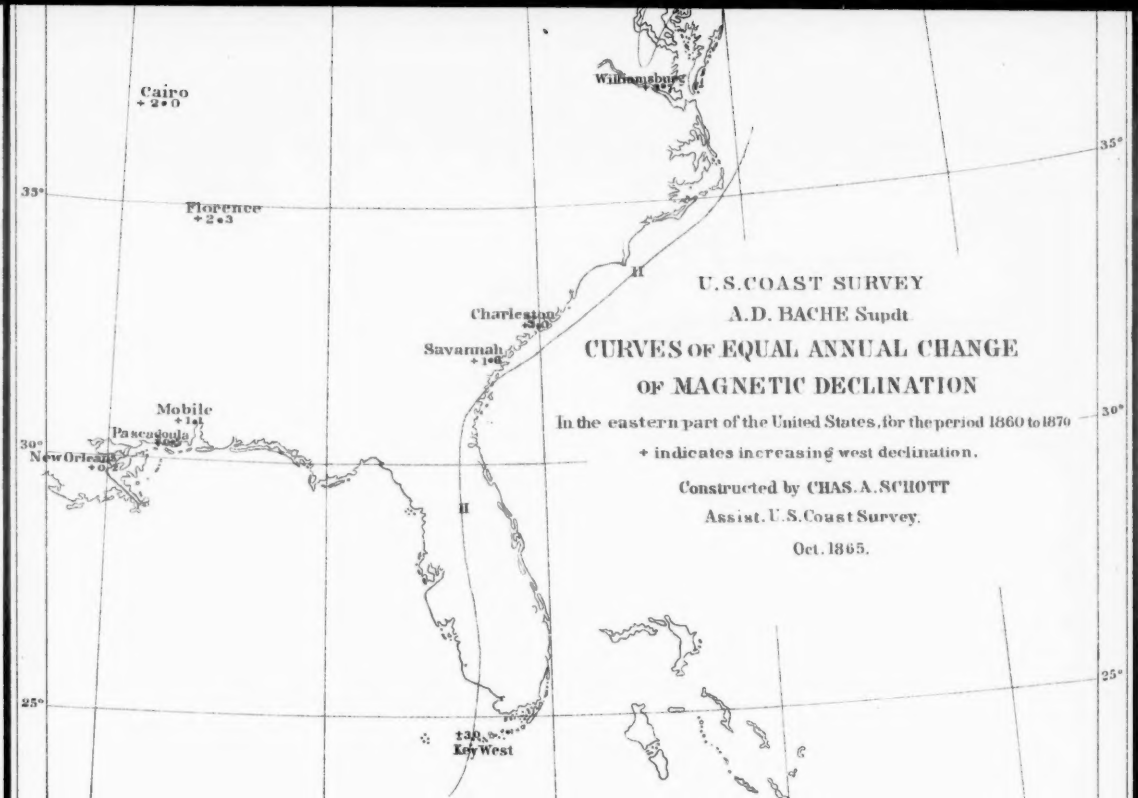
U.S. COAST SURVEY
A.D. BACHE Supdt.
CURVES OF EQUAL ANNUAL CHANGE
OF MAGNETIC DECLINATION
In the eastern part of the United States, for the period 1860 to 1870
+ indicates increasing west declination.
Constructed by CHAS. A. SCHOTT
Assist. U.S. Coast Survey.
Oct. 1865.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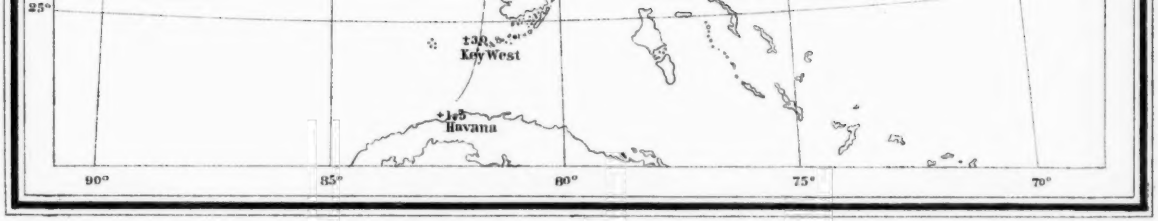
25°
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